MIKHAIL LEMESHEV

BUREAUCRATS in POWER – ECOLOGICAL COLLAPSE

ECOLOGICAL ALTERNATIVE

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INTRODUCTION

The history of human society is a chronicle of relations not only between people but also between man and nature. This chronicle is that of alternating periods of storm and calm, of ups and downs in the development of art and science. There were times of great geographical discoveries, of destructive wars and liberation movements. The history of man is also that of outstanding technical discoveries and inventions. The relations between man and nature have never stood still. At first they were simpler but later grew more complicated. However, on the whole they did not change radically. The contradictions between society and nature never reached a barrier where they could not be resolved.

Things are different in the 20th century which is variously called the nuclear age, the space age, the age of information glut, the age of computers which, with all its achievements, has brought us to the threshold of a global ecological crisis, a crisis that can destroy not only human civilisation, but all living things on earth.

A mere several decades ago most people had not even heard the word "ecology", let alone knowing the meaning of the problems that stand at the root of life, at the root of the existence of humanity. Today the situation has changed drastically. We are literally flooded with information about environmental pollution, about the destruction and degradation of nature. It is hard to find a scientific publication which, in one way or another, does not touch upon the ecological aspects of technological, economic, social and cultural progress. Literary, political and technical journals come out in millions of copies. These shed light on the deteriorating relations between nature and society. These are echoed by radio, television, cinema, theatre, public meetings and rallies. Millions of people in all countries are getting increasingly concerned about the ecological situation. There are good reasons for that, of course. Just think of the following figures: every year 6 million hectares of fertile land are lost to desert; 11 million hectares of forests are put to the axe, or are victims of forest fires and atmospheric pollution; about 1 million plant and animal species vanish from the face of the Earth; 14,000 people die of pesticide contamination, 700,000 people fall ill from drinking contaminated water and from living in areas of intensive air pollution.

Pollution of seas and oceans has assumed catastrophic dimensions. Large and small rivers carry masses of sewage, industrial waste, fertilizers and toxic chemicals washed off the farm fields; some bodies of water are used for dumping radioactive and highly toxic waste; the extraction of mineral wealth from the continental shelf is growing, which is fraught with accidents. Sea shipping, and especially crude oil transportation is also a major source of pollution. As a result, the excessive contamination of sea water brings destruction to marine flora and fauna, disrupts global gas and heat exchange between the ocean and the atmosphere.

The world economy throws out into the atmosphere about 200 million tons of carbon dioxide, 150 million tons of sulphur dioxide, 120 million tons of dust, tens of millions of tons of other pollutants. This anthropogenic pressure on the atmosphere has assumed a global character (disintegration of the ozone layer, the hothouse effect), which may well lead to irreversible disruptions in the biosphere as a whole.

Ecological problems are at their worst in densely populated and industrially advanced Europe. Acid rains are gradually turning it into a "balding continent". More than half of the forests of West Germany, which are known for their orderly management and their high productivity, are in various stages of decline. The forecasts are even bleaker for the near future. According to experts, 90 per cent of all forests in West Germany will perish by the year 2000. In Switzerland, about one third of the forest stands are dying. At present about 18,000 water bodies in Sweden have been contaminated by acid rains. Of this number 9,000 water bodies have depleted fish life, and 4,000 have no fish left at all. Significantly, 50 per cent of contamination in Sweden comes from abroad, notably from Britain.

The Soviet Union also has its share of ecological problems. In 1986 the total amount of pollutants discharged into the atmosphere exceeded 100 million tons. About 62 per cent of this amount came from factories and other stationary sources and 38 per cent from motor vehicles. The concentration of pollutants in the air of almost a hundred cities is ten times over the admissible level. The ecological situation shows no marked improvement to this day.

Humankind is clearly aware of an approaching global ecological catastrophe and is trying to ward it off. Moreover, a solution to the problem is being sought not only at scientific laboratories and research centres, industrial establishments and nature conservation societies, but also at government level.

Specialised agencies, committees or national agencies have been set up in 159 UN member countries whose job it is to protect the environment. The governments of many, if not all, countries have taken scores of seemingly effective laws and decrees on nature conservation. Major international, bilateral, multilateral, regional and world ecological organisations have been set up. Taking part in the work of one such organisation was the author of this book. For many years I headed a group in the UN Economic Commission for Europe, studying the technogenic impact on the environment. Individual states and international organisations are developing hundreds of costly projects for the protection of the atmosphere, water, the plant and animal world, and specific natural object. All these projects provide for costly measures to fight nature contamination with chemicals: sulphur dioxide, nitric oxides, fluorine, mercury, phenols, etc. The conflict between man and nature is assuming an increasingly dramatic character.

Why is it that all these measures are not effective? Maybe we are fighting against the consequences and not against the cause of this phenomenon? Maybe our requirements are too extravagant and unreasonable? Or maybe our objectives are too ambitious? In this book I shall attempt to answer this and other questions.

The problem of making production more ecology-orientated and consumption more rational concerns not only some individual countries and regions of the world. This is a gnawing world-wide problem because the ecological balance cannot be redressed in every individual country separately. When certain West European countries and the United States ship radioactive and other toxic wastes out to other countries including the Soviet Union, they only temporarily ward off ecological disaster but do not prevent it altogether. In these conditions knowledge of the ecological situation of one country is absolutely necessary for taking conservation measures in other countries. This makes it all the more necessary to take decisions for the whole of the world community.

Therefore one of the principal objectives of this book is to give a fair assessment of the ecological situation that is taking shape in the Soviet Union, to look for ways to coordinate economic growth, on the one hand, and nature conservation, the amelioration of man's own habitat, on the other. In other words, to find a way to our survival. The author admits that some provisions and conclusions in this book are open to question. As the great French naturalist Jean Baptiste Pierre Antoine de Monet Lamarck (1744-1829) said "it would probably be better if a newly discovered truth were long ignored and opposed than if any human fantasy were given a favourable reception".

Chapter One

INTERACTION BETWEEN MAN AND NATURE

In our pragmatic age, with its run-away urbanisation, unchallenged domination of technology, and growing consumerism man is drifting further and further away from nature. People labour under the false impression that they are independent of nature. They are getting an increasingly utilitarian view of nature as a source of material for the production of more and more goods. Economic managers are concerned about the state of nature in so far as the reserves of arable land and easily accessible water resources are dwindling. On their part, consumers get often, but not always, upset that there is less fish in rivers and lakes and that the once plentiful berries and mushrooms are getting scarce. This picture provides a fairly accurate idea of how we feel about nature. With its various irreplaceable resources and functions, with its material and aesthetic benefits, nature must not be regarded as a mere source of raw material for the development of production. No matter how much we may be flattered by the contention that man is the "king of nature", we must admit that besides sounding overambitious, this view is plain wrong and even harmful. Alas, all of us must yet understand that man is not the "king of nature", but rather the crowning achievement of its creation. Frederick Engels said that "we, with flesh, blood and brain, belong to nature, and exist in its midst, and that all our mastery of it consists in the fact that we have the advantage over all other creatures of being able to learn its laws and apply them correctly".[1]

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[1] Frederick Engels, "Dialectics of Nature", in: Karl Marx and Frederick Engels, *Collected Works*, Vol. 25, Progress Publishers, Moscow, 1987, p. 461.

For the sake of justice we must ask ourselves if we know the laws of nature sufficiently well and if we understand correctly at least those of them that we know. I am afraid that most of us will give a negative answer. In these conditions, the best conclusion we come to is that the life of man and society must not in any way be contrasted to the natural environment. It is unwise to wage a struggle against nature as some sort of hostile force. The "conquest" of nature of which many of us speak as an important task is not only thankless and useless, but also immoral, because such a conquest leads to the enslavement of man as a social being, as well as a biological species.

To successfully solve the many problems of the modern world we must go back in history source. The celebrated Russian historian Sergei Soloviev used to say: "Tell us your history, and we shall tell you who you are."[2] Let's follow his precepts.

1. The Historical Unity of Man and Nature

Let's make a short essay into history to see what the interrelation between man and nature was in bygone days?

The first thing that introduces us to history is the fact that our ancestors were aware of their close ties with nature. This can be judged from the study of the history of ancient Greece and the adjacent countries of the Aegean Sea. In the minds of their residents, all the forces of nature, all of its phenomena and even the various natural features — mountains, forests, rivers and the seas — were personified by powerful, immortal beings, or gods which the people of ancient times presented as some sort of ideal creatures endowed with the feelings of ordinary people (joy, sadness, anger, envy, hatred, kindness, etc.).

In their myths the ancient Greeks tell fascinating stories about the good and evil deeds of gods, i. e. the forces

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[1] S. Soloviev, *Selected Works*, Moscow University Press, 1983, p. 5 (in Russian).

and phenomena of nature, also about the heroic deeds and adventures of men endowed with supernatural strength, agility, and courage, which made them invincible in struggle. These heroes were the children of gods, i. e. they were, in the minds of the ancients, the children of nature.

In the world outlook of the ancient Greeks everything emerged out of Chaos: the world itself and all the immortal gods. The first to appear out of Chaos was Gaea, the goddess of the Earth. The grateful bountiful Earth brought forth everything that lived and grew on it. The Earth also gave birth to the boundless blue sky — Uranus. The handsome Uranus made Gaea his wife. They brought forth six daughters and six sons. All of them were mighty and handsome. Among them was the Titan Oceanus that embraced the whole Earth. The Titan married his sister Thetys and they gave birth to rivers which rolled their water to the sea. They also gave birth to the Oceanids— sea goddesses. Oceanus' brother, Hyperion, married his own sister Teia. Hyperion and Teia brought forth the Sun (Helios), the Moon (Selena) and the radiant Dawn (Eos). The Titan Astraeus and Eos created stars which shine brightly in the dark night sky, and the strong north wind, Boreas, the east dry wind Eurus, the moist and hot south wind Notus, and the gentle west wind Zephyrus that carried clouds and abundant rains. The ancient Greeks peopled the Earth with numerous gods in the image of men. These are Zeus and Leda, Paris and Helena, Heracles and Aphrodite, Odysseus and Sisyphus, and many others. Characteristically, all of them are the children of the Earth, endowed with the features, passions and feelings of human beings. Gods and people are inseparable here: these are all the same creatures, the creations of the forces of nature.

For us, the present residents of the Earth, who seek to understand the relationship between man and nature, the symbolic image of the god-hero Antaeus, the son of Poseidon (the god of the sea) and Gaea (the goddess of the Earth) is of particular significance. Antaeus will always remain the symbol of wisdom in the hearts of all men, for he was invincible in struggle while he was in touch with the Earth, his mother. He was finally overcome when Heracles tore him away from the Earth and strangled him in the air.

To keep the unbreakable links with their homeland, their mother Earth — this is what this myth calls upon us to do, a myth that was created in ancient Greece thousands of years ago. How primitive and paltry are the ideas about the superiority of technology over nature which, supposedly, is to be transformed to serve man's needs... Isn't it time to stop and think if we should destroy the life-giving links with our mother Earth?

Marx had long since written: "An adult cannot become a child again or he becomes childish. But does not the naiveté of the child give him pleasure? ... Why should not the historical childhood of humanity, where it attained its most beautiful form exert an eternal charm as a stage that will never recur?"[1]

Mankind will never again go through this stage in its development. This, however, does not mean that we must forget about the golden age of humanity, or ignore the wisdom of our ancestors. The vitality of ancient Greek culture manifested itself, in the first place, in that it lent a determining influence on the cultural development of all modern European peoples. Pointing to this influence Engels wrote that "without the basis laid by Hellenism and the Roman Empire ... no modern Europe"[2] was possible.

Of no less interest is the history of relations between man and nature in Ancient Rus. The archeological data and folklore records and their interpretation from present-day positions point to the organic unity of man and nature in Ancient Rus, particularly in the Slavic heartland in the middle reaches of the Dnieper. Historians and archeologists believe that the ancient Slavs lived in the middle reaches of the Dnieper in both pre-Scythian and

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[1] Karl Marx, "Economic Manuscripts of 1857-58", in Karl Marx and Frederick Engels, *Collected Works*, Vol. 28, p. 47, 48.

[2] Frederick Engels, "Anti-Dühring", *Collected Works*, Vol. 25, p. 168.

Scythian times. This postulate is borne out by mythology and epics with their roots in nature, as, for example, in the written records of Herodotus, also in Ukrainian-Russian and Byelorussian folklore. Herodotus writes about King Colaxais (Sun-King), whereas Slavic folklore features the fairy-tale hero tsarevich Svetovik, Svetozar, Zorevik and the well-known Vladimir Krasnoye Solnyshko (Vladimir the Red Sun, the prince of Kiev).

The richest of historical and cultural monuments among the three groups of Scythian culture on the territory of present-day Ukraine is the Kievan group. It was found along the Dnieper (which Herodotus called the Borysthenes) and extended from Kiev down the river Vorskla over a distance of about 400 km. In Herodotus's words this was a 10-11 days' sail.[1]

Dominating on these lands were pagan religions which in their outward manifestations took the form of prayers for harvests, various incantations, or of an appeal to the forces of nature, to good and evil spirits which, according to the ancient Slavs, were omnipresent. When people turned to these forces for help they usually went to a wellspring or a green meadow, to a river bank or a glade, a farm field (which the ancient Slavs called **niva**, or life). The indispensable feature of such rituals was flowers, and freshly cut birch twigs, and huge bon-fires on the river bank. Sometimes shrines were built for just one celebration; also permanent houses of worship for traditional rituals were built. They were decorated with wooden or stone images of Slavic pagan gods. All that did not interfere with the natural surroundings, but, on the contrary, blended with them. The most common rituals were roundelays, dancing, choral singing, and collective bathing. The indispensable attribute of such bathing was a bon-fire the making of which was entrusted to a woman. Bathing rituals were always linked with agrarian magic (the top of the summer — i. e. July), when farm crops came to flower. The central figure in all these rituals was Makosh-Kupala, who was surrounded with solar symbols and was always depicted (and still is in Russian embroidery) with arms stretching down to the fruited earth. The head of Makosh-Kupala was fringed with ears of wheat. This attire can still be seen in the festive folk dresses of Ukrainian women.

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[1] B. Rybakov, *Paganism in Ancient Rus*, Nauka Publishers, Moscow, 1987, pp. 45-46 (in Russian).

Makosh was the goddess of earthly fertility, who at the same time was an intermediary between the sky and the earth. This is why in the spring cycle of rituals Makosh was always portrayed with her hands outstretched towards the sky, as if symbolising supplication for warmth and rain.

Analysing these rituals Academician Boris Rybakov points out that the ancient farmer had to act upon nature. He did so not by destroying it, but "by appealing to its vegetative powers, by turning to its plant life, to sacred trees, to water sources—springs, wells, pools of cold water—also to farm fields during ploughing, sowing and the raising of the precious harvest".[1]

The rituals that accompanied various agricultural operations were profoundly symbolic. Before he put the plough to the land, the farmer begged forgiveness of the earth for "ripping up its breast". But not only for that. People asked the earth's forgiveness for their misdeeds. This feeling was so deeply ingrained that it continued over many centuries. In his novel *Crime and Punishment*, Dostoyevsky takes Raskolnikov to Sennaya Square to beg forgiveness of the earth for the murder he had committed. And even in our time, people say at the funeral "take the ashes of the deceased to your bosom, mother Earth".

The most revered tree was the oak. In the minds of the ancient Slavs the oak was the tree of the God Perun. The strongest, the mightiest and the most durable, the oak was the dominant plant in the latitudes where our ancestors lived. It was particularly valued, and not accidentally became very much part of the ancient Slavic pagan rituals. We must specifically note here that the cult of the oak continued in Russia until the 19th century. Old timers in

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[1] B. Rybakov, *op. cit.*, pp. 121-39, 205, 511-15, 672-73.

Russian villages still remember that the wedding train went around a lone oak tree three times. Unfortunately, in our days, the few remaining Russian oak groves are dying out because of the contaminated atmosphere, or are in a very poor state of preservation.

Significantly, the ancient Slavs, besides these simple and pragmatic appeals to forest and water, also worshipped mountains and hills which, in their minds, were associated with nature as the vehicles of life, with those great powers that resided in the sky and governed all of nature as one unified system, using the modern term. We can't help wondering at this remarkable prescience and at the cosmogonic views of our ancestors which sound relevant to this day. Regrettably, it is only now that we are slowly beginning to understand the importance of this approach largely thanks to the Russian scientist Vladimir Vernadsky.

The Slavic cult of water, mountains, the sun and the stars was so much part of their thinking that it left a deep imprint in the eastern Slavic toponymics with its hundreds of holy mountains and holy streams, holy groves, holy well-springs, "red" (beautiful) hills, and holy oak groves, holy gullies, and holy wells. The significance of the by-names of natural objects is great. After all, these were not just places where various religious rituals were performed. In a sense these names protected them from destruction. Since they were "holy" nobody would raise their hand against the trees and chop them down, would dump litter upon such wellsprings, level off a knoll, or plough up a hill, or commit any other act of sacrilege.

The chronicles about Perun, the god of thunder and lightning, always place him high on top of a hill. When Kievan Prince Igor (?—945) put the seal of his oath on the treaty with Byzantium, he enjoined: "come to the hills where Perun once stood". Prince Vladimir I (?—1015) placed pagan idols on top of Staro-Kievskaya Mountain overlooking the Dnieper. These traditions continued over many centuries. After the baptising of Rus the pagan shrines on holy hills were turned into Christian temples.

Hundreds and even thousands of villages, even the smallest of them, have since been called after pagan gods: Perunovo, Velesovo, Yarilino, Yarilki, etc. Local residents never thought of calling such a village "an economic deadend", or abandoning it, or moving it to another place. It could never have occurred to our distant ancestors to commit such an act of sacrilege.

The caring attitude to nature was typical not only of the areas along the middle reaches of the Dnieper. From here ancient Slavic culture moved in broad streams across the Seversky lands, along the mixed forest-steppe zones, to Central Russia (Ryazan) along the River Oka. Historians believe that Ryazan means "the edge", or the end. This means that in the 7th century the Russian lands stretched from the Dnieper and Bug in the west to the Oka in the north-east. Evidence of this is the stone icon described by Academician Rybakov. This icon from Old Ryazan, dating back to the 13th century, carries the images of the first Russian saints, Boris and Gleb. Although these are not pagan symbols of faith, but wholly Christian religious relics, the garments of Boris are covered with symbols of cereal seeds and bear a picture of a farm field, which corresponds to the spring festival marking the ploughing and sowing seasons. Gleb is shown with tendrils of growing plants. Thus the Orthodox Christian festival of Boris and Gleb instituted by the Russian church in 1072 for the Second of May was timed for the ancient pagan festival of sowing, when plants were just sprouting their green shoots.

A caring attitude to the environment which stemmed from pagan faiths, later passed into the secular life of the Russian people and was reflected in the laws and decrees of the Russian state.

According to N. Grave, a celebrated sylviculturist, *Russkaya Pravda*, a code of ancient Russian laws, which is believed to have been adopted at the congress of the Yaroslaviches in Vyshegorod in 1072, also the *Decree of the Yaroslaviches*, and the *Ordinance of the Czar Alexei Mikhailovich*, and some other documents of the 11th-17th centuries, contain articles on the responsibility for trespassing the land, forest and for doing harm to wild animals.[1]

A document called the *Judgement of Yaroslav Vladimirovich*, which was in legal use in Kiev Rus, contained a list of fines for forest violations. Legal acts on nature protection were also contained in the laws of the Russian State in later times. This was done not only in the interests of protection of private property, but also in the interests of protection and reproduction of natural resources. Significant in this respect is the law about beaver habitats. Beaver fur was prized very highly not only in Russia, but also in other lands. In the practice of the 15th-17th centuries, vast tracts of lowlands could be bought or exchanged specifically because of beavers living on them. N. Grave points out that it would have been fair and proper from the legal point of view to return stray beavers to the land from which they had moved. But the law did not work that way. It took the beavers rather than the landowners under its protection. Article 214 of the Ordinance of the Czar Alexei Mikhailovich, read: "If beavers leave one man's land and enter another man's land, and then make their home in the new place, thus abandoning their old home, he who previously owned them on his land now can no longer claim the animals as his property."

The arable land and meadows, whoever they might belong to, were also protected by the laws of Old Russia. Article 238 of the Ordinance prescribed *"to build water mills so as not to flood meadows and ploughfields upstream"* (my italics.— *M. L.*).

Article 220 provided heavy fines for forest cutting. Article 223 imposed penalties upon those guilty of arson.

In his *ukases* (decrees) Peter the Great meted out severe punishments, including the death penalty, for the unauthorised cutting down of timber used in shipbuilding.

It stands to reason, however, that a caring and in fact a reverent attitude to nature could not rest only on legal measures, or fear of punishment for its destruction. The protection of nature in Russia was always a matter for the entire community. All their members cleared river beds and courses, kept the forests clean, built roads through them, planted trees and bushes around gullies, cleared meadows and grazing fields.

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[1] N. Grave, "Nature Protection in Ancient Rus", *Knizhnoye obozrenie*, 1985, No. 39, p. 12.

Significantly, Russian folklore, painting, sculpture, wood-carving, embroidery and singing, gave nature much prominence. All creations of the human mind and hands are full of images of nature. There are still many twinned words in the Russian language, such as mother-earth, tsarina-water, father-forest, little foxes-little sisters, hemp-the-green head, etc. Ancient Russian culture which developed not only in unity with nature, but indeed on its basis, is no exception. Suffice it to remember the fascinating myths and legends of the North American Indians where man, animals, fish and herbs are fused into one whole (totem poles). There are many vivid images of the unity of man and nature that we can see in folk art across the world.

Why was, then, this eternal harmony between man and nature broken up? Why is this harmony disintegrating at an ever higher pace, taking in ever more spheres of the environment, including all of us?

2. Disintegration of Unity Between Man and Nature: Sources and Causes

> You cannot escape fate; in other words you cannot escape the necessary consequences of your own actions.
>
> *Engels*

Mankind is thousands of years old. Over this period, different civilisations rose into being, flourished and ... vanished. Even one and the same nation may have replaced one culture with another, one faith with another. But man's relations with nature remained practically unchanged. Very possibly, the change occurred somewhere in the course of the gradual transition of mankind from gathering and hunting to land tilling and livestock breeding. However, this important shift in the development of the forces of production, too, did not introduce any radical change in the relations between man and nature. People continued to make use of nature's own forces, and built up their economy by land tilling based on draught cattle and on the use of organic fertilizers, or manure, by expanding grassland farming and pasturable live-stock breeding, wild honey farming (naturally reproduced forest apiculture), by stocking up of mushrooms, berries, nuts, medicinal herbs, and other gifts of the forest. The principal energy sources were wind and running or falling water.

The predominantly rural way of life and the rural occupations, all of which were closely tied with the land, forest and rivers, formed strong links between man and nature. Dependence on the conditions and the character of nature, the need to adjust to its seasonal rythms, periodical and unforeseen cataclysms inevitably inspired in the hard-working man great respect for nature. The first signs of disruption in relations between man and nature emerged in the days of feudalism, under the influence of growing cities and the spreading urban style of living. The development of crafts and tools of labour made it possible to make use of the resources of nature.

Having accomplished the first and second industrial revolutions capitalism drastically changed the character of the forces of production and production technologies on the basis of the invention of the steam engine and later on the basis of the discovery and practical utilisation of electricity. This, in turn, transformed the entire character of relations between human society and nature. The moloch of continuously developing industry claimed more and more sacrifices from nature, many of which have never been redeemed.

The feudal economy was almost exclusively based on the extensive use of land resources, whereas under capitalism a wider range of natural resources was drawn into production. The deposits of coal, especially in combination with those of iron ore, played a particularly important role in the economic development of the leading capitalist countries (Britain, Germany and France). It is well known that the exploitation of these and other resources attained great proportions. "For the first time, nature becomes purely an object for men, nothing more than a matter of utility. It ceases to be acknowledged as a power for itself, and even the theoretical cognition of its autonomous laws appears merely as a stratagem for its subjection to human needs, whether as object of consumption or as means of production."[1]

Alongside the development of the forces of production, capitalism also brought forth the spirit of utilitarianism, pragmatism, and commercialism which stimulated private initiative, brought forth the predatory attitude to nature which capitalists used as an object of cruel exploitation. Capitalism squeezed resources out of the environment the same way as it "squeezed the sweat" out of workers. To make more profit, capitalists extensively extracted minerals, chopped down forests, ploughed up virgin soil, polluted rivers, lakes and the air. The relations between society and nature in many parts of the world, especially in industrial centres, were at a critical point. Monopoly capitalism has aggravated these negative tendencies even more. Many Western scientists studying the relationship between nature and society thought, until recently, that this process was irreversible. Some of them still believe that mankind is moving towards an ecological crisis and, consequently, towards its own end.

Bourgeois scientists reject the ruinous attitude of society towards nature, and therefore are inclined to interpret the tragedy of the modern ecological situation by man's intrinsic aggressiveness, his greed for profit and in general by his inner imperfection. Quite indicative in this respect is the contention of scientist and social activist W. Douglas. He writes in his book *The Three Hundred Year War* that people regardless of race and colour are intrinsically bent on destruction. Their motto has never been peace, but war alone. Every generation fights its own war, whose cruelty is bound to grow with time as the result of so-called achievements of science and technology. The brutal rape of the environment by man is still another form of destruction which threatens his very existence. This is most likely a manifestation of forces that reside somewhere deep in our subconscious.[1]

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[1] Karl Marx, "Economic Manuscripts of 1857-58", in: Karl Marx and Frederick Engels, *Collected Works*, Vol. 28, p. 337.

These and similar statements are typical of Western scientists and public figures.

This is easy to explain. In the conditions where production is fully geared to maximum profit this is the only way the economy can operate, because natural wealth is viewed as some sort of exploitable resource. The less money is spent on this resource, the more successfully will the businessman achieve his goal. Advanced capital must bring profit and if nature suffers from it, so much the worse for nature. Such is the economic profile of capitalism.

In the conditions where private property predominates this situation is easy to explain. As development of resource-saving and pollution-free technologies involve additional expenditures and thus reduce his profit, the capitalist, naturally, is reluctant to introduce them. This attitude is quite natural, because, with all the rivalry between monopolies, any reduction in the level of profit will inevitably lead him to a financial collapse.

Narrow group and departmental ambitions make these problems existent under the socialist system. Some economists of the socialist community, including those in the Soviet Union, are inclined to regard the expenditures on nature conservation as some sort of deduction from the national income. They regard the growth of these expenditures as a factor that makes socialist production less effective.

We believe that this concept is based on delusions that may have far-reaching consequences. These delusions stem from the view on nature as a source of raw materials. Hence, the less costly this raw material is for an industrial establishment, the higher profits it derives from its operations. I would like to add here that this attitude may benefit isolated production units but it certainly does not benefit man and human society as a whole.

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[1] William O. Douglas, *The Three Hundred Year War: A Chronicle of Ecological Disaster*, New York, Random House, 1972.

It is also well-known that the ultimate goal of socialist production is not to assure economic effectiveness per se although this is the most important requirement for its development, but to assure, in Lenin's words, "*full* well-being and free, *all-round* development for *all* the members of society".[1]

It is impossible to achieve this goal without the rational utilization of natural resources. In the conditions of socialism, with its state ownership of natural resources, the contradictions between the interests of industrial establishments and the interests of society in the sphere of nature conservation arise from the administrative-bureaucratic practice of planning and management, from the imperfections of economic relations in the sphere of nature utilisation (which will be dealt with in more detail later on).

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Whatever the goals and principles of social development, the contradictions between man and nature, between production and ecological systems are inevitable. All we can say here is that these contradictions may vary in intensity and that ways to resolve them may not be the same.

The point is that today the size of the world's population is growing very rapidly. In 1700 it was 600 million, by 1850 it had grown to 1.2 billion, by 1950 to 2.5 billion, and by the middle of 1987 it was 5 billion. This means that it took 150 years to double the population starting with the early 17th century. The second doubling of the population took 100 years, and the third doubling took less than 37 years.

The requirements of people are also growing, and they do so not proportionately to the growth of the population but at a much higher rate, largely owing to the expansion of the range, quality and quantity of the commodities consumed. This can be judged from data over the last quarter of this century (see Table 1). These constantly growing requirements can be satisfied only by intensifying production.

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[1] V. I. Lenin, "Notes on Plekhanov's Second Draft Programme", *Collected Works*, Vol. 6, Progress Publishers, Moscow, 1977, p. 52.

Table 1

Growth of Population and Production in the World

	1960	1986	1986 compared to 1960 (%)
Population (million)	3,000	4,917	164
Electric power (million kwh)	2,356	10,100	425
Oil (million tons)	1,053	2,827	281
Gas (billion m^3)	453	1,727	381
Steel (million tons)	348	720	207
Mineral fertilizers (million tons)	30	141	470
Cement (million tons)	319	992	311

As you see, the population of the globe has, over the past quarter of a century, grown by 60 per cent, whereas the production of industrial goods has grown 2 to 5 times.

Development of production is impossible without utilisation of natural resources. Every year man draws from nature tens of billions of tons of materials—coal, ore, oil, gas, building materials, water, wood, farming produce, etc. Ever greater tracts of virgin land, more and more agricultural and forest land are being taken over by factories and plants, by storage lakes, by mining projects, motorways, pipelines, power lines, airfields, residential communities, especially cities. Back in the early years of our century cities accounted for 10 per cent of the population of the earth. Today the proportion of city-dwellers exceeds 40 per cent. According to some forecasts, more than half the population of the world will be living in cities by the year 2000. These are averaged-out data. In some countries this percentage is much higher. In the

Unites States, the proportion of the urban population is 74 per cent, in Britain and Japan 76 per cent, in Australia 86 per cent, in Spain 91 per cent and West Germany 94 per cent.

The most baneful effect on the natural environment is technogenic pollution which, in some parts of the world, has reached a critical point both with regard to the stability of ecological systems and human health. The following data show the discharge of contaminants into the atmosphere in the second half of the 20th century. According to some computations, about 6 million tons of sulphur dioxide was dumped into the atmosphere in the year 1860. Sixty years later, in 1920 about 50 million tons of sulphur dioxide was discharged, in 1940—65 million tons, in 1965—110 million tons, and in 1985 180 million tons. The discharge of carbon dioxide had grown by the year 1985 three times over that of 1950 to a total of 200 million tons.[1]

The contamination of the atmosphere is accompanied by the mass destruction of forests, the lungs of our planet, by poorer harvests of agricultural crops, by the lower productivity of fisheries. It is also damaging to human health.

What is the *main reason* for this situation? Can it be corrected?

Many specialists in the West, after reading the works of the members of the Club of Rome, notably *The Limits to Growth* by D. Meadows and his colleagues, held the one-sided view that the main reason for ecological setbacks was the growth of the population and the runaway increase in production. We do not deny the existence of these initial factors of the negative effect on the natural environment. At the same time we think it necessary to make some adjustments to this contentions.

First, there were times in history when ecological disaster overtook some parts of the world as the result of economic activity. That happened long ago when the density of the population in these afflicted countries was by the present standards, infinitesimally small and industrial production, in the modern sense, did not exist at all. A good example of this is the sad experience of Mesopotamia and Greece where rich grazing lands were ruined by cattle. In Lebanon the cutting of cedar groves resulted in wide-spread desertification. Second, high population density and the extensive industrial potential are not necessarily accompanied by high concentrations of pollution or by the degradation of the natural environment. The experience of some other countries bears out this point. In Japan, the average density of the population is 325 per square kilometre, in Turkey 63 people. As you see, population density in Japan is five times as great as in Turkey. The industrial potential in Japan, too, is considerably greater than in Turkey. In spite of all that, the level of environmental pollution, notably air pollution, is lower in Japan than in Turkey. A similar situation obtains in many other countries.

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[1] *Environmental Data Report*, UNEP, New York, 1987.

Hence the conclusion that the growth of the population and industrial production must not be regarded as the main reason for exacerbation of the conflict between society and nature. Besides, there is no practical possibility of stopping the growth of population in the foreseeable future.

According to UN demographic estimates, the world population will in 2025 reach 8 billion and will level off at 10 billion only in some 100-110 years.

It is impossible to stop the growth of industrial production, since the population is growing, and so are its needs. All the more so if we take into account that hundreds of millions of people in the developing countries are starving, and many of them have no jobs, decent housing and have not got adequate medical facilities. Taking into account the fact that the population there is still growing the only way is to *alter the structure of production*, to re-orientate production towards the satisfaction of human needs. Such re-orientation can in large part be achieved by limiting and, ideally, stopping arms manufacturing, which consumes tremendous amounts of labour, natural, material and financial resources. Suffice it to say, about one trillion dollars are spent annually on military needs in the world. A mere 1/5 of this amount would be sufficient to stamp out famine by the year 2000. Come to think of it, 20,000 dollars are spent on one soldier every year, as compared to 380 dollars on one school pupil. Total renunciation of arms manufacturing would, given the same total volume of industrial production, satisfy much better the growing requirements of people, and, consequently, reduce the rate of growth in industrial production. Here is just one example of this possibility. Desertification is taking a heavy toll of fertile land and fresh water on our planet. At present the total desert area is 5 billion hectares, i. e. one hectare per head of population. In principle it is quite possible to arrest the advance of desert. This problem is the subject of a major international project which is being developed under the aegis of the UNEP programme and the MAB (Man and the Biosphere) programme. Taking part in the development of this project are scientists and specialists from many countries, including the Soviet Union. According to present estimates, it may take 70 billion dollars to accomplish this project before the end of this century. However, over the same period the arms race will eat up a thousand times more money, or 150,000 billion dollars, if the sums keep on growing at the same rate as today.

The arms drive, especially in the field of nuclear weapons, not only consumes tremendous resources which could well be used for nature conservation, and not only opens the gate to a global ecological crisis, but also threatens modern civilisation with destruction. This has irrefutably been proven by basic theoretical studies carried out over the past few years. Thus, the Academician N. N. Moiseyev and professor Yu. M. Svirezhev and their coworkers at the Computer Centre of the Academy of Sciences of the USSR made a detailed study of the changes in the biosphere that might occur as the result of nuclear war. They found out that should such a war break out, the very structure of the biosphere would be affected. Most of the higher animals and plants would most likely perish in the holocaust. The worst hit would be the equatorial and temperate zones of the Earth.

This shows that the arms race, especially the nuclear arms race, is the most dangerous of all the existing causes of the deterioration and possible complete disintegration of the natural environment. It also shows the main obstacle to its conservation and improvement.

The negative effect of industrial production on the environment clearly comes not only from its irrational structure, but also from faulty technological processes. This has been borne out by the fact that only 1.5-2.0 per cent of the tremendous amount of natural material are actually put to good use. Most of this material is transformed into industrial and domestic waste which pollutes the air, water and soil, and which is damaging to human health.

This nature-destructive activity will inevitably lead to a crisis situation in relations between man and nature.

Starting with the late 1960s and in the early 1970s, the once seemingly inexhaustible natural resources began to shrink rapidly. Industrial pollution affects not only individual cities and localities, but indeed whole regions and territories far beyond national boundaries, the Baltic and the North Sea being a case in point. In the North Sea large accumulations of sea weeds bring death to fish, seals, sea stars. The emergence of such weeds was dealt with in a report on the condition of the North Sea prepared a year ago by a research group made up of representatives of all countries of the region. It says that every year tens of millions of tons of harmful substances of varying toxicity get into the sea water: zinc — almost 30,000 tons, lead — about 11,000 tons, arsenic — 1,000 tons, etc. Also 100,000 tons of phosphates and 1.5 million tons of nitric compounds.

In addition to that sea-going vessels and oil drilling platforms may dump their legitimate quota of up to 150,000 tons of oil, not to speak of tons and tons of oil dumped above this quota.

The first sign of the approaching ecological catastrophe was the mass death of seals in the North Sea, which has led scientists to warn people against swimming in the sea. This is the price paid for the rapid growth of ecologically destructive industrial production.

The energy crisis in the 1970s, the International Geophysical Year in the Antarctic, the expeditions of Jacques Ives Cousteau and Thor Heyerdal, showed the disastrous effect that human behaviour has on nature, the growing threat of an ecological crisis. Many people are anxious about the future of our planet. Many, but not all of them. There are many economic managers, technologists and even scientists, with their traditional way of thinking, who still insist that man should "conquer" nature. What is more, in their view anyone who voices concern about the destruction of nature is an "alarmist".

As for estimates of the future ecological situation in the Soviet Union, high-ranking representatives of the Communist Party, planning and economic bodies, together with scientists high up in the pecking order stubbornly insisted that in the USSR, with its planned economic system, there can be no ecological crisis. Typical in this respect was the position of the well-known representative of the administrative bureaucratic sector of Soviet science, academician E. Fyodorov who wrote: "The predatory character of the capitalist economy that comes from private ownership of natural resources and the means of production, from the desire to make maximum profit, all of which create the principal elements of the conflict with the natural environment, stands in sharp contrast with the planned development of socialist society, with its inherent rational utilization of natural resources, with the preservation and target-oriented planned modification of the natural environment."

This irresponsible optimism was voiced not in the 1920s when the country was still swept by naive revolutionary ardour, when its industry was making its first gigantic steps, when ecological problems preoccupied only very few of the more far-sighted scientists endowed with systems thinking. Not at all! Those words were written in 1977 when ecological problems in the country had been grossly exacerbated, when the prodigal squandering of natural resources and the dangerous level of environmental pollution had become public knowledge. We shall add to this that these words were said not by an outsider, not by a provincial journalist, and not by a pettifagging propaganda-monger, but by one of the leading members of the State Committee of the USSR for Hydrometeorology and Environmental Control, one of the top-ranking officials in science who shaped the strategy and tactic of nature protection in this country.

Such patterns of thinking come from the erroneous idea that the very existence of public property and of the planned economic management automatically assured rational utilisation of natural resources and environmental protection from pollution and degradation.

This had dangerous consequences. For many years the Soviet economic development plans were worked out and materialised without the account of the law of value. In other words, Soviet planners sought to increase production regardless of the cost involved. Hence the cost-intensive approach to the economy which provided for an extensive, resource-intensive character of its development. And since economic planning gives top priority to the production of more commodities, with no consideration given to cost efficiency, some of the no less important needs are unavoidably left unmet, owing to the lack of material, financial and labour resources. When priority goes to the production of goods and services regardless of the expenditure of socially necessary labour, it leads to the waste of all resources and primarily natural resources. Hence the *chronic shortage of resources*, in spite of the high rates of their extraction. In the final analysis, the high rate of growth results not so much in the satisfaction of social needs as in the depletion of natural resources and in the pollution of the natural environment. This is the price we have to pay for ignoring economic laws and the laws of nature.

3. A General Characteristic of the Ecological Situation in the USSR

There is hardly a person anywhere in the world who does not understand the need for nature protection. There are exceptions of course, but we shall talk about them somewhat later. What we want to stress now is that the idea of our dependence on nature, of our thrifty, caring attitude to it, the idea of interaction between man and nature which is important for their mutual survival is becoming closer and closer to everyone. People are becoming increasingly aware that their well-being is increasingly dependent on the quality of the environment.

Since the ideas of nature protection have become close to the hearts and minds of the millions, it would seem that there must be no barriers in solving ecological problems. This is not so. People continue to commit acts of blasphemy against nature. Their destructive activities, their violation of nature not only have not stopped, but are getting worse and are assuming global proportions.

The Soviet Union is no exception to this, although nature conservation is part of its socio-economic strategy. The basic provisions of environmental protection are enshrined in a number of legal acts, including the fundamental law of the Soviet Union, the Constitution of the USSR. "In the interests of the present and future generations, the necessary steps are taken in the USSR to protect and make scientific, rational use of the land and its mineral and water resources, and the plant and animal kingdoms, to preserve the purity of air and water, ensure reproduction of natural wealth, and improve the human environment."

And yet the problems of environmental improvement and reproduction are not being resolved to our satisfaction. Many years have passed since the Central Committee of the CPSU and the Council of Ministers of the USSR adopted their decree "On improving nature protection measures and on making rational use of natural resources" (1972). Starting with 1975, nature protecting assignments have been included in national economic plans that is each ministry was given its respective target. In 1978, the same bodies adopted a decree "On additional measures to boost nature protection and to utilise natural resources more rationally". In July 1985 the Supreme Soviet of the USSR adopted a decree "On the observance of the requirements of Soviet legislature on nature protection and on rational utilisation of natural resources". In January 1988 another decree "On measures to reform the organisation of nature protection in the country" was issued.

As you see, there have been many decrees and laws on nature conservation, but no marked progress has so far been made. To be fair, headway has been made in this respect. In the first place a lot more money is allocated for nature conservation. In 1971-1975 the government allocated 7.3 billion roubles on conservation measures, whereas in 1981-85 this sum grew to 11.1 billion roubles. Moreover, the total outlays including current ones made by the Soviet state and individual enterprises have over the 1981-88 period exceeded 75 billion roubles.

Over the Tenth and Eleventh Five-Year Plan periods major installations for purification of industrial and domestic effluent (63.7 million cu m a day) were put into service. Also set up were circulating water supply systems (243 million cu m a day), installations for catching and detoxifying harmful substances from waste gas (372.4 cu m/hour). As a result, at present almost three quarters of water consumption in industry come from circulating water supply systems. About 80 per cent of harmful substances in waste gases is trapped and detoxicated. The amount of fresh water taken directly from natural sources has been somewhat reduced. The area of recultivated land has grown, and so has the area of wild life preserves and national parks (in 1987 there were 156 preserves and 18 national parks with a total area of 20.7 million hectares).

However, these positive measures must be viewed as the first and rather modest steps towards improvement of the alarming ecological situation. The level of pollution of our rivers, lakes, storage reservoirs is too high, while the quality of the water in such rivers as the Volga, Ob, Irtysh, Kama, Don, Kuban has even deteriorated. In 1987, the total amount of sewage water contaminated above the "permissible level" was 15 cu km. Significantly, 6.5 cu km of sewage water was dumped into rivers and lakes without prior purification.

The damage inflicted upon our natural water bodies can be illustrated by the fact that 1 cu m of unpurified sewage water can contaminate and render unusable 60 cu m of clean water.

Atmospheric pollution is particularly dangerous for human health and the national economy. In 1987, the total amount of toxins discharged into the atmosphere was over 100 million tons. About 65 million tons of this amount came from industrial facilities, 5.6 million tons from municipal facilities and services, 36 million tons from motor vehicles, and other means of transportation used in industry and agriculture. Particularly massive was the discharge of carbon dioxide (about 45 million tons), sulphur dioxide (20 million tons), solid particles (18 million tons), carbo hydrates (about 15 million tons), nitric oxides (7 million tons).

The principal sources of atmospheric pollution are thermal power stations, iron-and-steel mills, non-ferrous smelting plants, oil refineries, petrochemical plants, and building materials manufacturing establishments.

The per capita discharge of pollutants into the air comes roughly to 350 kg. This figure is much higher in such areas as industrial centres and cities where many of the above industrial facilities are concentrated. A very high concentration of toxic discharge is typical of the nation's oldest industrial regions, such as the Urals, the Don region and the area along the River Dnieper. Toxic discharge is growing in the newly developed industrial regions in Western Siberia, Kazakhstan, in Eastern Siberia.

A very tense ecological situation has developed in a number of industrial cities: Ekibastuz, Krivoi Rog, Novokuznetsk, Norilsk, Temirtau, Mariupol, Nizhni Taghil, Cherepovets, Magnitogorsk, Ufa, Lipetsk, and other industrial centres. In such conurbations as Moscow, Leningrad, Baku, Tashkent, Kiev, Tbilisi, Alma Ata, and Yerevan the main source of air pollution is motor vehicles.

According to the environmental supervision-and-control authorities, in about 100 cities air pollution has exceeded maximum permissible levels over a number of years, whereas for some pollutants its intensity has exceeded such levels ten times over.

The intensive pollution of the atmosphere with sulphur and nitric compounds leads to the precipitation of acid rain which brings damage to forests, farm crops, water reservoirs, soil, also upon cultural and historical monuments, various structures, etc. Soil erosion is affecting more and more land, vast areas are open to partial and total flooding as the result of the building of giant storage lakes. Faulty and poorly organised irrigation leads to the salination, waterlogging and eventual destruction of the soil. All this leeches out the soil in the farm fields, depletes it of its natural fertility, raises unit outlays in both land cultivation and livestock breeding. Excessive water expenditure takes place in industry and agriculture. Indiscriminate timber cutting, also great losses of oil, gas, coal, mineral wealth in mining, processing, transportation and utilisation have become a standard practice.

The main consumer of water is irrigation farming where only half the amount of water drawn from fresh water sources reaches its target: farm crops. In the irrigation canals alone, one fourth the amount of water is lost through filtering. This outrageous waste of nature's most precious resource can be explained by the fact that the officials of Minvodkhoz[1] (Ministry for Water Management), and its local agencies are used to the fact that water is drawn free of charge, is fed through canals with earthern banks. In Uzbekistan, for example, only about 8 per cent of canals are tile-protected, whereas in Turkmenia this figure is even lower. Besides, water gets lost in the network of feeder canals, its flow becoming weaker by the time it reaches the end of its run. As it seeps deeper and deeper into the soil the water swamps and salinates the fields, and destroys their fertility. The eroded land becomes deserted and new land of inferior quality is opened on with the help of the old technology based on water expenditure.

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[1] Now called Minvodstroi. Functions remain the same.—*Ed.*

Over many years the tonnage of the oil extracted has not exceeded 35-40 per cent of the proven reserves, although the more progressive method of secondary extraction could raise oil output up to 60-65 per cent. The incessant growth of oil production is accompanied by its exceedingly irrational utilisation in the USSR and by its massive export abroad, which exacerbates the shortage of this irreplaceable natural wealth.

In the USSR the depth of crude oil refining is 59 per cent, with fuel oil at 42 per cent. The index of depth of oil processing came into use at a time when the relation between extraction and refining unit outlays was 3:1. Today the index is 12:1. With this correlation, the structure of oil refining must be revised towards increasing the discharge of light petroleum products and bringing down the amount of fuel oil which is being gradually replaced by coal and gas. According to Western experience, the optimal depth of oil refining is 70 per cent. This deepening of oil refining will enable a 1.2—1.3 time increase in the production of motor fuel without actually increasing the extraction of oil.

The export of crude oil from the USSR to other countries grew from 18 million tons in 1960 to 137 million tons in 1987 and that of petroleum products from 15 million to 59 million tons. This practice flies in the face of nature conservation and the rational utilisation of natural wealth, because the extraction and refining of oil on an ever larger scale leads to the destruction of ecological systems and to environmental pollution over vast territories.

Great damage is inflicted upon natural landscape by mining operations, especially by the extraction of metal ore and coal, by the so-called "progressive" open-cut method. Thus, one million tons of coal mined underground alienates 8 ha whereas open-cut mining alienates 20 and even 30 ha of land.

Utilisation of heavy machinery in agriculture, faulty soil amelioration, disruption of crop rotation, also overgrasing have led to mechanical, wind and water erosion over many millions of hectares of arable land. The depletion of humus and other organic substances in the soil is becoming increasingly widespread.

Timber resources are also going to waste, with most of the slash left behind after cutting and logging. Utilisation of heavy hauling machinery destroys the undergrowth and soil over large areas. Overcutting of coniferous forests is also common. Timber felling and processing technology falls short of modern standards. New methods of waste-free utilisation of timber and other products of the forest are being introduced at an exruciatingly slow pace. Very little is being done for fuller and more rational utilisation of soft varieties of wood in the European part of the USSR, and of the larch in Siberia and in the Far East. Much forest material gets flooded in the course of the building of hydroelectric power-stations and in timber rafting, which worsens the sanitary condition of water bodies, and inflicts heavy damage upon fisheries.

The depletion of natural resources in our country can be illustrated by the fact that the Red Data Book of the USSR includes 62 species and subspecies of mammals, 63 species and subspecies of birds, 8 species of amphibia, 21 species of reptiles, 444 species of vascular plants.

The extensive growth of industry and agriculture characteristic of this country especially over the past few decades, has unavoidably led to the irrational utilisation of natural resources, also to rapid degradation and contamination of the environment. It weakens ecological control, disrupts normal conditions for the reproduction of biocenosis. And this, in turn, creates vast areas of crisis-stricken ecological situations, such as those around Lake Baikal, Ladoga, the Sea of Azov, Aral Sea and in the lower reaches of the Kuban, Volga, Amu Darya, in the areas of Ekibastuz and the Kursk magnetic anomaly, also in a number of major cities and industrial centres. All that, in the final analysis, reduces the socio-economic effectiveness of the normal production process in industry and agriculture, disrupts the ecological balance, worsens the conditions of man's own environment and holds down the living standard.

In practical terms nature conservation could benefit from better economic management. The absence of effective economic levers and stimuli discourages industrial managers from assuring complex and rational utilisation of natural resources, and from reducing environmental pollution.

At present scores of government departments are supposed to be monitoring the quality of the environment in this country. However, in reality none of them protect nature from pollution and from the depletion of its resources. To this day we have no integrated standards of quality for the state of the biosphere and the natural environment. For example, the data on atmospheric pollution do not tie in with the quality of water in rivers and lakes. The admissible level of pollution of fields with chemicals, also the excessive use of fertilisers are not regulated. There is no reliable supervision and control over the condition of the surface waters and the soil cover. No scientific standards of expenditure of natural resources per unit of final products have yet been worked out.

As you see, the situation is clearly abnormal. But why is it so? There are several reasons for it: insufficient knowledge of the rather complex ecological problems, imperfection of technology and technical facilities, their ecological incompatibility, lack of funds allocated for nature protection. All that is correct, of course, but the main reason for this abnormal situation lies elsewhere. Our ecological troubles stem from the faulty mechanism of our economic management, from the differences between social, collective and personal interests, differences that stem from the warped attitude toward property. In his report to the plenary meeting of the Central Committee of the CPSU in January 1987, Mikhail Gorbachev gave a forthright estimate to this negative phenomenon. This is what he said in his well argumented, Leninist-style evaluation: "Special mention should be made of socialist property. Control over those who managed it and how had slackened. Departmental and parochial attitudes eroded socialist property, it became 'no one's', free, belonging to irreal owner and in many cases was used to derive unearned income."

What is the mechanism of destruction of nature under socialism? In our view this destruction stems from the desire to satisfy the ever growing requirements of the members of society at the lowest possible expense; the country traditionally practises extensive development of production based on relatively cheap but at the same time resource-intensive, high-waste, pollution-producing technologies, which makes the effect of socialist mode of production upon nature tantamount to the effect that capitalist production has on it. What is more, many Soviet enterprises do their best to cut their environment expenditures so as to ensure more profit.

Chapter Two

ECONOMY AND NATURE: CONSTITUENTS OR OPPOSITES?

Human society cannot under any circumstances stop using natural wealth for the simple reason that it lives by material production, which, in turn, is the transformation of natural resources into consumer goods through human labour. In Marx's definition, labour "is human action with a view to the production of use-values, appropriation of natural substances to human requirements; it is the necessary condition for effecting exchange of matter between man and Nature; it is the everlasting Nature-imposed condition of human existence."[1]

But is the activity of human society always rational?

With the development of science and technology, with the growth of production forces, society can bring more and more pressure to bear upon nature in order to use its resources and its natural forces for the satisfaction of its "constantly growing requirements". This pressure, however, is of two types. It can stimulate the development of nature, improve it, increase the useful productivity of natural biological systems (land and forests, animals, plants, microorganisms, etc.), if people, in their association with nature, get to know the laws of nature and follow these laws. Regrettably, in real life all these indispensable requirements are mostly ignored. As a result, the growth of production is often accompanied by an extensive disruption of natural systems and by the intensive contamination of the natural environment, which is damaging to nature and human society.

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[1] Karl Marx, *Capital*, Volume I, Progress Publishers, Moscow, 1983, p. 179.

Humanity is confronted by the task of how to make rational and meaningful use of nature to satisfy the vital needs of people in a way that would not only preserve but indeed replenish and enrich our natural environment. How far can society succeed in achieving this optimal interrelationship with nature? It has been proved that we still have to go a long way towards resolving this task.

1. Creation and Destruction of Nature

> Let us not, however, flatter ourselves overmuch on account of our human victories over nature. For each such victory nature takes its revenge on us. Each victory, it is true, in the first place brings about the results we expected, but in the second and third places it has quite different, unforeseen effects which only too often cancel the first.
>
> *Engels*

Every year there are more and more unforeseen consequences of our "victories" over nature. The most far-reaching of these is the depletion of the most precious natural resources and the contamination of the natural environment. We owe all that to the incessant and continually expanding development of production.

The attempts of society to avoid these rather dramatic consequences have failed, and the numerous nature protection measures have proved ineffectual. The contradictions between society and nature continue to exacerbate. Why is it so? The problem is that we are fighting against the effect and not against the cause of a negative phenomenon. After all, the contaminants, which go into thousands of varieties, are the side-products of rapidly expanding industry and agriculture.

The question suggests itself: does society really need such rapid production growth? I am convinced that this is not so. To prove my point I shall look into just one technological chain of modern industrial production. Mankind extracts a lot of metal ore. In this country we extract 250 million tons of ore a year, which is five times as much as in the United States. As we extract ore by the so-called progressive open-cut method we destroy thousands of hectares of precious black earth, disrupt the hydrological regime of vast regions, and in this way create an artificial water shortage. To process the ore and obtain metal we build large ore-dressing mills and then metal smelting plants. The smelting of metal leads to the contamination of air and water resources. The molten metal is used for the building of giant rolling mills. On these mills steel profiles are roll-formed. These profiles are assembled into rotary excavators which are used for extracting iron ore. One such "monster" has tremendous productivity, but actually it has tremendous destructive force, as it can dig up 5,500 cu m of earth an hour. The whole operation consumes a tremendous amount of energy and physical labour. Thus we come full circle followed by a new technological spiral, with the same appallingly low efficiency in terms of obtaining final consumer benefits for people at the tragic expense of the natural environment.

This somewhat simplified, but quite realistic example is characteristic also of other industries. One of them is the power industry. Here in the USSR we extract tremendous amounts of oil, gas and coal: an annual total of about 2.5 billion tons of reference fuel. Its lion's share is used for technological needs, notably for the generation of electric power. The total volume of electric power generated in the USSR in 1988 has reached 1,7 trillion kwh a year. Three quarters of this amount are used for industrial needs, agriculture and transportation. Considering losses of electric power in the mains, the net amount of electricity for household needs is very small. This means that the power resources are largely used for the generation of power resources. Moreover their production and energy conversion (such as the burning of oil, gas and coal and the utilisation of its heat for the production of electric power) have the most destructive effect on the environment.

So here again we come full circle. This much desired economic growth which lies on the surface of social development is nothing but a Pyrrhic victory, because it is achieved through the destruction of nature and through the degradation of the quality of the environment. We have much too long lulled ourselves with the hope that the more extensive the manufacture of commodities, the sooner our society will become prosperous. Life has dispelled these radiant hopes.

What lies at the root of our mistakes? To my mind the main problem stems from the fact that our socio-economic and ecological (if any) thinking has taken shape in the shadow of two, what we thought were fundamental, and actually rather dubious, hypotheses. In the first place our planners, and indeed economists have much too long, until very recently, believed our natural resources to be inexhaustible. They regarded our country as one with boundless expanses where man could penetrate into the natural environment as much as he deemed necessary. Second, decision-making people firmly believed that the very principles of out state and social system would protect us from making mistakes. And even now when we all know that there is no such thing as inexhaustible natural wealth, that all of it will eventually get depleted, we still cannot bring ourselves to admit this incontestible truth: nature is indifferent to the intentions and purposes, however good, for which her wealth is used, but it sure is not indifferent and responds promptly and painfully to how and on what scale it is done. For instance, a forestry manager, inspired by the idea of serving his nation, and who quite sincerely wants to overfulfill the production plan, destroys the forest under his authority and not only becomes the enemy of nature, but also undermines his country's future.

In pursuit of higher development rates we spend the lion's share of the newly created product for making extended production still more extensive. In this context you can clearly see that protection of nature plays second fiddle to production. We set ourselves new targets in production growth, are glad when we achieve this growth, and are upset (not all of us and not necessarily) that our industrial progress proceeds side by side with the despoliation of nature. After that we make a virtue of necessity by setting nature protection targets. One can easily notice here that with this practice in view, production growth and nature protection are the two tasks that are poles apart and are therefore regarded separately one from the other. Production growth is always given priority over nature protection. Suffice it to say that party and economic leaders of all ranks devote their main attention to production. Hence the so-called "residual" principle of allocation of funds and technology for nature protection after all the other expenses have been made, a guiding principle adopted by party bodies, government ministries, departments, industrial establishments and organisations.

One must emphasise here that with this approach in view, the required standards of nature protection cannot be achieved even if the funds and other resources are increased manyfold. The main problem here is that the creation of even the most sophisticated modern machinery and purification installations cannot guarantee the adequate protection of the natural environment. First, there is no guarantee that accidents will not happen. There is no such thing as hundred per cent safety in any domain of human activity, much less in the sphere of modern industrial production. Hence the greater the scale of production, the greater the possibility of accidents, even if all the other conditions are the same.

There is yet another important point to make. To assure greater ecological safety and greater reliability of any technical system, it is necessary to drastically improve the quality of building and assembly work, to use the right kind of materials, to achieve high standards in the manufacture, repair work and modernisation of equipment. The technical state of equipment needs strict supervision and control at all stages and modes of its exploitation.

It goes without saying that if the production of steel is reduced say from the current 163 million tons a year to 81 million tons, its quality can be improved much easier than if its quantity remains the same or, all the more so, if its output is increased. The same goes for machine building. For example, it is easier to find good metal, rubber, manufacturing equipment and skilled personnel for the manufacture of 125,000 tractors than for the manufacture of 559,000 tractors a year as practised today.

In the light of the aforesaid, one can come to the conclusion that a smaller number of modern quality tractors can be used for ploughing smaller plots of better land, meeting all the requirements of agrotechnology and at the same time obtaining more, better and also cheaper produce.

Still more glaring examples are provided by livestock breeding where quality has a direct bearing on quantity. In 1987 we had 42.4 million milk cows in this country. Most of them are given some 60-70 per cent of the feed they should consume, and in some areas even less. A large percentage are old, sick, barren, low-grade animals. Therefore their productivity both for milk and meat is low. If the cow population were half as great, the situation would soon improve for the better. This would automatically solve the problem of feed for cattle, would improve the quality of the cow population, and raise the productivity of the animals. It should also be added here that this approach would ease the problem of labour shortage and would require half the size of cowshed accommodation. This is a tremendous saving on capital funds and building materials. After all, according to modern so-called massive industrial projects, the building of accommodation for just one cow takes up 8 cu m of ferro-concrete, and 4 thousand roubles of capital investment, which by far exceeds the cost of building of a condominium apartment for one citizen.

Extensive production development is economically irrational and ecologically dangerous also from the point of view of scientific and technological progress. According to Academican V. Legasov, modern chemistry is becoming one of the key factors in the development of the power industry, in the production of new materials, in ensuring ecological safety in many industries. In other words, chemistry is largely responsible for the development of the economy in all its sectors. Accordingly, the amount of chemical products is growing rapidly and today runs into 90,000 items. As a result of this chemical boom only one fifth of these chemicals are produced with an eye to all-round, detailed scientific (also ecological) research. Production processes for more than 90 per cent of all these chemicals have not been optimised, which inevitably leads to a tremendous loss of energy, raw material, labour resources, to deterioration of the quality of products, and to unfavourable ecological effects. Unfortunately, the situation is not getting any better as time goes on. Every year about 600 new chemicals are developed for mass production, and only one third this number is produced in accordance with optimal technological standards.

Thus the extensive way of production development unavoidably leads to squandering natural resources, increases environmental pollution, creates further shortage of material and labour resources, reduces the quality of products, disrupts the normal conditions of reproduction, also of the natural and production systems. All this, in the final analysis, reduces the socio-economic effectiveness of social production, worsens the conditions of human habitat and holds down the rise in the living standards.

Speaking in Tyumen Mikhail Gorbachev said back in September 1985: "We cannot and shall not support the managers who go by the old methods, by the old norms, and who view speedy growth of production as a way of getting more material resources." The idea is correct but still unmaterialised because to this day these resources are at the disposal of government departments.

Thus only the general public comes out strongly in support of environmental protection. But the general public has no resources of its own. The almighty industrial leaders can call these demands "emotional" and not to be treated seriously.

It is necessary to bring home the simple truth that it is impossible to fundamentally improve the quality of the natural environment without reducing the volume of nature-intensive production and without using low-waste or waste-free technologies. Can this be achieved? Would such reduced production bring down the national income and, consequently, the living standard?

An economic analysis shows that there is no such danger, and that this task is feasible. It is precisely this reduced production with no harmful effects on nature that is so important for raising the living standards. The thing is that a reduction in the volume of production is not an aim in itself. The idea is to change the structure of social production, to reorient it from the manufacturing of primarily intermediate products (coal, ore, metal, oil, cement, tractors, turbines, machine tools, etc.) to the manufacturing of final products that are meant to satisfy human needs (foodstuffs, clothing, footwear, housing, household goods, utilities, and public health service, etc). Such reorientation can be achieved by utilising the achievements of scientific and technological progress which enables a sharp reduction in material, energy and labour intensity of the national income and in the consumer funds, also a sharp reduction in the wasteful utilisation of natural resources, and in environmental pollution.

The possibilities of such reduction in the Soviet Union are tremendous. Here are comparative data on the basic types of industrial production and on the national income in the USSR and the USA.

Table 2

Dynamics of Production in the USSR and the USA

	USSR		USA	
	1970	1988	1970	1988
Oil, including gas condensate (million tons)	353	624	475	405
Gas (billion cu m)	200	770	621	490
Iron ore (million tons)	195	250	91	54
Steel (million tons)	116	163	122	90
Cement (million tons)	95	139	87	76
Tractors (thou.)	459	559	224	100
National income in the USSR in relation to that in the USA (%)	66	64	100	100

All this is clear enough. In the United States industries based on the exploitation of natural resources have been winding down production over the past 15 or so years. In our country, by contrast, such industries have, until recently, been increasing production. It goes without saying that the output of intermediate products in our country over that in America is 1.5—5.0 times as great, with roughly the same or similar technologies in use, this has a multiple negative effect on the natural environment and in turn sharply exacerbates the problem of its conservation and improvement.

The excuse that is usually given by Soviet planners and economic managers for the steady increase in the manufacture of intermediate products is the need for overcoming the shortage of these products. Moreover, the decision-makers seem to pass over the fact that with the growth of production of goods in short supply, given the existing structure of production, their shortage is not getting any smaller, but, on the contrary, is worsening. A good example here is electric power production. In 1960 the USSR generated 292 billion kwh of electricity. In 1988 its production had grown 5.7 times over to 1,705 billion kwh. Significantly, there was no apparent shortage of electric power in 1960. Electric trains in those days ran on schedule, the streets in the cities were brightly lit, and industrial establishments worked smoothly, with the up-time ratio being even higher than today. In 1988 the shortage of electric power and frequent interruptions in electric power supply caused many industrial enterprises to go on a loose schedule, which badly affected the performance of industrial enterprises with a continuous production cycle.

The 27th Congress worked out a new strategy for the Soviet economy to develop more intensively by reducing resource consumption. However, this so far the only correct strategy is not followed. For example, overall metal intensity was reduced by 2 per cent in 1986-88 as against 2.3 per cent in 1981-85. Before 1990 metal intensity is expected to be reduced by 6.9 per cent and power intensity by 5.3 per cent. The speed at which resource intensity is being reduced is clearly not sufficient for achieving ecologically sound progress in industry, considering the fact that the USSR expends significantly more energy and metal per unit of production then industrial states. Even with much lesser initial power intensity, the United States reduced the power intensity of its gross national product by 33 per cent and Japan by 78 per cent over 1971-1985.

Every branch of our economy has potential for tangibly reducing the material and energy intensity of production.

In metallurgy, for example, the total metal fund (all metal parts of machinery, equipment and other production assets) of this country has now exceeded 1.6 billion tons. The Soviet national economy still has too much obsolescent machinery and equipment. In 1988, a mere 2.2 per cent of this machinery and equipment were scrapped and replaced. Even with such a low replacement rate the total amount of scrap metal runs into tens of millions of tons.

Significantly, only a small percentage of this important material was made use of. Under the current five-year plan, with its emphasis on speedy renewal and renovation, 10 per cent of machinery and industrial plant is to be replaced annually. This increases the amount of scrap metal for resmelting and makes it possible to almost completely abandon the smelting of metal from iron ore and in this way to reduce its production and processing. A move like this can fundamentally change the situation in both the economy and ecology. The point is that the smelting of steel from scrap metal considerably raises its quality and consequently reduces the use of metal in machine building. At the same time the cost of steel production would be only 14 to 20 per cent of what it is from prime material. The expenditure of fuel and power would also go down dramatically. Moreover, the pollution of air would go down six times, and of water five times, which would almost completely rule out environmental pollution with hard waste. Reduction of iron ore extraction would, in turn, save tens of thousands of hectares of precious black earth, stop the destruction of landscapes, disruption of the hydrological regime over vast territories around mining sites.

Similar resource-saving and nature-protecting decisions are possible in any sector of the economy. However, the extensive development stereotype in the economic thinking that took shape in the period of stagnation is being overcome very slowly.

Speaking at a meeting between members of the Central Committee of the CPSU and workers in culture on January 8, 1988, Mikhail Gorbachev said that "it would be unrealistic to think that we have already smashed the built-in breaking mechanism that holds back our economic development, that we have fully adopted the principles of socialist democracy, and have set the new economic mechanism in motion".

In these conditions the newly formed state committee for nature conservation must formulate a new scientific strategy of developing resource-saving technologies in all sectors of the national economy, and put this strategy to work. The newly organised special ecological committee of the USSR Supreme Soviet is charged with control functions.

2. Industry: the Boon and Bane of Modern Civilisation

> It is as impossible for human labour to supercede the forces of Nature as it is to substitute pounds for yards. Both in industry and in agriculture, man can only utilise the forces of Nature when he has learned how they operate, and he can facilitate this utilisation by means of machinery, tools, etc.
>
> *Lenin*

The title of this chapter may have raised many eyebrows. How could industry be anything but beneficial to mankind? Isn't it clear to anyone except maybe to some eccentrics (of whom there have always been many in any society) that we owe all of our most impressive modern achievements to the development of industry? Hasn't industry assured the high living standards for millions of people in the advanced countries of the West? Or, isn't it the weakness of industry or its total absence that have reduced billions of people in the countries of the Third World to economic misery?

All that may be true, because industry plays a crucial role in the life of society. Yet, to get a better picture, let's take a closer look at the situation and size up modern industrial production from a historical and ecological angle or from the point of view of the optimal utilisation of natural resources. The USSR, being the world's first socialist country that grew up amidst a capitalist encirclement, had to develop its industry apace. The industrial drive was largely prompted by the need to strengthen its defence capability and to assure its economic independence from the external world, and primarily from German and Japanese militarism. Having rather limited material and financial recources, scientific and technical personnel the USSR was compelled to use the same cheap and nature-despoiling industrial technologies as the capitalist countries.

Fortunately, the scales of production in the 1920s were modest and because of that the first decade after the revolution both industry and agriculture developed in relative harmony, which can be judged from the following figures in *Table 3*:

Table 3

Growth of Industrial and Agricultural Production in the USSR in the 1920s (per cent)

	1913	1920	1925	1928
Industrial production	100	22	73	132
Agricultural production	100	67	112	124

This shows that during the period of reconstruction that followed the First World War and the Civil War, the young Soviet economy grew fairly rapidly, with all its sectors developing proportionately to one another, which is particularly important. Thanks to Lenin's new economic policy /NEP/ the Soviet national economy which lay in ruins had not only been restored, but actually surpassed the pre-war level. In 1928 the pre-war level in industry was exceeded by 33 per cent and in agriculture by 25 per cent. Significantly, it was not only light industry that was developing. Heavy industry was also making rapid headway. For example, the pre-war level of production of electricity was exceeded already in 1925, and that of oil and coal in 1927.

After a period of fairly well-coordinated and balanced development of industry and agriculture, the country was plunged into forced industrialisation, with the emphasis on heavy industry. For example, between 1918 and 1928, about 2,200 primarily small and medium-sized industrial enterprises were restored or built anew, whereas between 1929 and 1937 six thousand large and giant industrial enterprises were built. Taken on its own merit this dramatic growth of industry was justified to some degree: it was necessary to build a modern industrial foundation for the national economy, credit for which went to the Soviet people. However, one of the striking features of this industrial drive was the fact that this forced growth of heavy industry was achieved at the expense of agriculture and consumer goods industry. Such growth resulted in unjustified suffering for the people and in heavy losses for the natural environment.

The basic proportions of the country's economic growth were disrupted, which is illustrated by the following figures.

Table 4

Economic Growth of the USSR in the 1930s
(1928 = 1)

indicators	1932	1937	1940
New fixed assets put into use	4.2	5.4	7.5
Industrial production	2.0	4.5	6.5
Labour productivity in industry	1.3	2.4	3.1
Agricultural production	0.9	1.1	1.3
Labour productivity in agriculture	1.1	1.6	1.7

Industrial growth was achieved extensively, i. e. primarily by increasing the number of low-paid workers, i. e. former peasants who had been forcibly taken off their land. On its part agriculture was undermined and fell into decay because of unjustified forced collectivisation. In the early 1930s agricultural production dropped sharply and regained its level only in 1937. Considering that the population of the country increased over that period from 147 to 194.1 ml, i. e. by 32 per cent, it is clear that per capita agricultural production took a downward trend. Millions of people starved to death or suffered cruelly from famine. The lagging of agriculture as traditionally the most effective sector of the economy not only affected the living standard but also upset the normal course of social reproduction, since this sector had no accumulations necessary for the proportionate development of the national economy as a whole.

Significantly, industrial output increased 6.5 times in the 1930s, whereas labour productivity in industry rose a mere 3.1 times. This means that it was mostly unskilled manual labour that was used in industry. Nonetheless, this policy was carried out under the slogan "Let's overtake and outstrip the capitalist countries in industrial production".

With all this high-pressure growth of Soviet industry and with the nation's limited resources, industrial enterprises were built with total disregard for ecological requirements. Actually no such requirements were officially spelled out, much less made obligatory. Most of the technologies used in those days were cheap, waste-producing and contaminating the environment over large areas. Industrial operations were carried out on a comparatively small scale, whereas an ecological information at public disposal in those days was very limited. Therefore the giant smokestacks towering over factories and plants, and the long plumes of belching smoke were presented as symbols of progress and technical might. And that was precisely when the essentially technocratic view began to take shape, which was shared not only by engineers and technologists, but also by Marxist philosophers, agronomists, biologists and even writers and artists. Typical in this respect were the words of Maxim Gorky who had this to say: "In the Soviet Union, the scientifically organised human reason has gained full freedom in its struggle against the elemental forces of nature. By conquering these forces and making them serve obediently the great cause of building a world-wide class-free society of equals this reason more and more audaciously, successfully and tangibly manifests the full strength of the creator and organiser of the second nature, i. e. the creator of man-made culture on the soil, on the forces and treasures of the already existing first nature which is ancient, unorganised and even hostile to the interests of the working man."

The so-called "industrial landscapes" often featured in the works of many Soviet artists. Incidentally, such painting can often be seen at art exhibitions today, too. Even the poets' society organised in the 1930s was called "the Proletarian Smithy". What this industrial drive cost us in terms of ecological losses in those days could well be explained and understood. People then strongly believed in the omnipotence of technology disregarding the creative capacities of morality.

During the Second World War when all our resources and all our efforts and aspirations served only one cause, the cause of victory over German nazism — that worst enemy of mankind — we just did not have either the time or the strength to protect the environment. During the first several years after the war when thousands of factories, plants, coal mines, and cities and towns lay in ruins, Soviet people were busy restoring them. No need to say that we just had no time for forest conservation when millions of Soviet people had no shelter. Forests were cut where they could be obtained easier, without any mechanised facilities — along railways and on river banks. Hundreds upon hundreds of plants and factories were built with high-waste and even ecologically dangerous production technologies. And all that was done for industrial growth, for creating the "foundation" of our future well-being. This practice could also be understood and forgiven.

What is unforgivable is the fact that now that we are so technologically strong, know so much and can do so much, we continue to display that unforgivable disparaging attitude to ecological problems, an attitude which has had such a ruinous effect on nature and on our own habitat.

The concept formulated by Marx and Lenin of the need for the preemptive growth of the means of production over the growth of consumer goods as a mandatory prerequisite for extended reproduction was interpreted by Soviet economists and planners, with their dogmatic understanding of the doctrine of Marxism-Leninism, as an absolute "must". This is why this concept was so doggedly translated into our daily economic practice. Between 1928 and 1940 the production of the means of production (Division "A" industries) grew 10 times over, whereas the production of consumer goods (Division "B" industries) a mere 4.2 times. That was also done for speeding up the development of industry. We have already pointed out that such a correlation in the development of these two divisions in those concrete historical and economic conditions was a forced measure in a way. Nevertheless, even in that period this correlation remained within more or less reasonable limits as they made it possible to accelerate the growth of social production, on the one hand, and to gradually increase the production of consumer goods and raise the living standard with minimum negative effects on the natural environment, on the other.

Later the technocratic trends in economic planning and management became so strong that they eventually led to a fundamental change in the existing rational correlation between the economy and nature. The proportions in the development of social production became somehow lop-sided and warped. This is borne out by the following figures.

Table 5

Correlation Between the Means of Production and Consumer Goods in Total Industrial Output in the Soviet Union (per cent)

Year	Total output	including	
		means of production (Division "A")	consumer goods (Division "B")
1940	100	61.0	39.0
1970	100	73.4	26.6
1980	100	73.8	26.2
1987	100	75.1	24.9

As you see, in 1940, two fifths of what the Soviet Union produced was consumer goods, whereas by 1987 this had fallen to under one fourth. Hence the growing shortage of consumer necessities, hence the growing anthropogenic pressure upon nature that puts it at risk of degradation. Thus the rapid growth of industrial development does not of its own raise the living standard. Everything depends on the structure of industrial production, on the character of the technologies used, on the purpose for which the final product is manufactured.

Of course, industry produces many useful things. But the price is too high, because people pay for it by forfeiting many other socio-economic, ecological and moral values. Here is an example from my own observations.

Twenty-five years ago I bought a *dacha* (country house) some 45 km from Moscow. The housing cooperative stood next to a village called Nagornoye on a picturesque hill. At that time the village had 100 peasant families who lived in 100 houses and owned 100 milk cows. Most of the able-bodied villagers worked in agriculture. The younger folk had jobs on the Maiski state farm, and those who were older tilled the land right outside their homes. They turned a good profit, proof of which was the solidly built cottages with orchards, vegetable gardens, and water wells nearby. In short the villagers were well off, and the city-dwellers who came there for the summer also had their share of the benefits of country life.

Any townsman living in a summer house in the country could easily arrange with a village woman about delivering fresh milk and vegetables in the morning, which she usually gladly provided because it saved her the trouble taking the products to the market place. The money she got for this service was also reasonably good.

But in the mid-sixties many new industrial enterprises mushroomed in the nearby towns of Pushkino, Mytishchi and Zagorsk. The need for workforce drew the farming population away from the land of the Maiski state farm to these newly built factories where pay was twice as high. Eventually, they abandoned their own plots of land, too. I felt pained to even think that the village of Nagornoye has only *one* cow left. Today the villagers go to Moscow to buy milk products, because there is no fresh milk available here even for local people, let alone *dachniks.*

Nagornoye is not the only example, of course. Such population shifts are taking place not only in the Moscow region, but also in farming areas, indeed all over the Soviet Union. Similar processes can be observed in the countries of Western Europe and in America, albeit at a slower pace.

I hope that the reader will understand that what I am saying is not just a petty peeve from a *dachnik* who has lost his little comforts in the countryside. The question at issue is something much more serious, as it concerns something that destroys the socio-economic wellbeing of society under the pressure of the senseless growth of industry. This is not to say that we should wish for a return to the "good old" patriarchal order, which would be impossible anyway. What I am trying to say is that we should make new assessments, that we need a new social philosophy, a *new thinking*.

The whole world, including the Soviet Union, follows the road of industrialisation. Today 32 per cent of the able-bodied population of the Soviet Union is engaged in industrial production, which is responsible for 33 per cent of the production assets, 60 per cent of the gross social product and 44 per cent of the country's national income. Typically, industrial production and especially heavy industry, is growing apace. In 1988, for example, overall industrial output rose by 127 per cent, with 163 per cent in heavy industry and 52 per cent in light industry. Significantly, the development of heavy industry is directly linked with the exploitation of natural resources.

Let's take a closer look at the ecological aspect of industrial growth. In the Soviet Union the annual amount of harmful substances discharged into the atmosphere alone from industrial facilities is 65 million tons, and from motor vehicles about 40 million tons. To better understand the burden this discharge puts on the natural environment and society, let's correlate this amount of pollutants with the size of the Soviet population. The result: 372 kilograms of toxic waste a year comes down from the air upon every citizen. This is an average figure for the whole country, and does not fully reveal the truly apalling ecological situation in some cities and industrial centres. There are record holders in this dismal competition, as for example, the city of Karaganda where the amount of pollutants, including the highly toxic ones, such as benzol, mercury, phenol, hydrogen cyanide, and others has reached 4 tons a year. But the true champion is the town of Karabash in the Urals where the annual per capita discharge of such toxic substances exceeds 10 tons. There are dead zones with a radius of 10 km around industrial enterprises in these and many other cities.

The greatest damage from industrial pollution is inflicted upon man himself, the creator of all technical facilities and production technologies. Man is the greatest of all the existing values on earth. His death, especially if it occurs too early, is a tragedy, an irretrievable loss. This is the moral side of the question. There is the economic side, too. In the USSR the rate of mortality per 1,000 persons in 1960 was 7.1, in 1970 it had grown to 8.2, and in 1988 the number of deaths was 9.8. And all that in spite of the fact that the government expenditure on public health service had in this period grown 4 times over. Is it possible to calculate the economic loss sustained by society from a growing mortality rate? Yes, it is.

Over 300 years ago, the outstanding British economist William Petty calculated the benefits coming from healthy labourers. Pointing out that each working man earned 69 pounds sterling a year, he figured out that "100,000 persons dying of the Plague, above the ordinary number, is near 7 Millions loss to the Kingdom; and consequently how well might 70,000 pounds sterling have been bestowed in preventing this Centuple loss."[1]

Regrettably, we still do not know the ratio between the rising sickness and mortality rates and growing environmental pollution. However, there is no doubt that such dependence does exist. According to our estimates, one working man in the Soviet Union creates an average of 4,500 roubles worth of national income a year. Hence the high rate of morbidity and mortality among able-bodied people due to environmental pollution means an annual loss of billions of roubles.

We can also say with a fair degree of accuracy about the social and economic loss from the high incidence of disease among the population due to environmental pollution. Doctors and hygienists can accurately trace a disease to this factor. For example, the incidence of disease in the town of Karabash is three and even four times as high as the average for the Chelyabinsk region on whose territory it stands, and 6-8 times as high as in what are called "clean" cities. Calculations show that the economic loss due to pollution-induced temporary disability in the USSR exceeds 10 billion roubles a year.

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[1] William Petty. Verbum Sapienti. in: William Petty, *The Political Anatomy of Ireland*, Irish University Press, Shannon, 1970, p. 8.

To make a detailed investigation into the causes of the negative and often disastrous effects of industry upon the natural environment we should scrutinize the activities of each of its branches separately. But even that would not be enough. To obtain credible evidence about sources of pollution, it is necessary to make an ecological analysis of the work of each individual enterprise of which there are tens of thousands in the USSR. It is true that ecological control is exercised at most of these enterprises by specialised agencies of the national hygiene and sanitation service, by water and soil inspectors, mining supervisory bodies, etc. However, such bodies can only register the discharge of contaminants but cannot change, much less improve, the existing environmental situation.

What we need is the ecological evaluation (certification) of the existing industrial plant, equipment and production methods used. In the Soviet Union this work is only starting now. In this book we shall discuss the activities of certain sectors of the economy that inflict the worst damage upon the natural environment, and will set forth some considerations about ways to reduce their harmful effect on the environment and on human health.

POWER INDUSTRY

The power industry is the backbone of the national economy. Let's look into its effects on the environment. The production of all types of fuels in the USSR (in terms of reference fuel) increased from 693 million in 1960 to

2,230 million tons in 1988, i. e. 3,2 times. Production of oil (including gas condensate) over the same period increased from 148 million tons to 624 million tons, that of natural gas from 45 billion cu m to 770 billion cu m, i. e. 4.2 and 17.1 times respectively. Production of electricity over that period increased from 292 billion kwh to 1,705 billion kwh, or 6 times. Electricity comes from thermal power stations (76.5 per cent), hydroelectric power stations (13.5 per cent) and nuclear power stations (10 per cent). The thermal power stations are the chief source of environmental contamination. Thus, even the best, modern stations that are designed and built with a view to the needs of environmental protection discharge a lot of waste. As a result, the power industry is the principal source, among all the other industries, of discharge of sulphur dioxide, carbon monoxide, nitric oxides, and dust (including the highly toxic heavy metals). Thermal power stations need large areas of usable land around for dumping ash and clinker. The thermal power stations operating on coal are, of course, the worst for pollution, with fuel oil and gas-operated thermal power stations coming next. All that creates a serious problem, considering the fact that the number of large thermal power stations runs into dozens and smaller thermal power stations into hundreds.

The situation is somewhat different with hydro power engineering. Minenergo (Ministry for Power Industry) and its main research organisation Gidroproekt (Hydroproject) usually give three reasons for the rapid construction of hydroelectric stations. The first reason is the alleged low cost of production. Second, hydroelectric stations are ecologically clean, since they do not pollute the environment. Third, such stations help regulate the flow of water in rivers, increasing their capacity. Facts suggest, however, that this optimistic view of hydroelectric stations is the product of purely departmental ambitions. This is easy to understand. The personnel of the Gidroproekt institute are 18,000 men and women who have for decades been busy designing new hydropower stations. Not surprisingly, they treat their every new project, every new "brainchild", with loving care. Sure, a more detailed and impartial analysis of the ecological soundness of hydroelectric stations shows that their protagonists' optimism is unfounded.

First, the relatively low cost of energy generated by these stations is achieved at the price of tremendous capital investments. More often than not, these funds are frozen for many years because of the slow pace of hydroelectric stations construction. Over the past twenty years the speed of construction has gone down to one third and even one fourth of what it used to be. For example, the construction of the Sayano-Shushenskaya hydroelectric station began in 1963, and was to be put into service in 1975. However, its construction is continuing to this day. Billions of roubles have been spent. It is true that several of its hydraulic turbines are already in operation, but the rest of them will be placed into service only in 1991. Thus the Sayano-Shushenskaya hydroelectric station will take twenty-eight years to build. The building of the Cheboksary hydroelectric station has been going on since 1969, with no end in sight. The problem is that some serious defects have been revealed, new updated project has been worked out but Minenergo procrastinates to examine it. Engineering defects beset many other hydroelectric stations. Lately the Gidroproekt has revised 52 projects. But millions of roubles of tax payers' money have already been spent on these projects. Thus all that talk about the cheap energy produced by hydroelectric stations is a hoax.

As for the *second* argument of the protagonists of hydroelectric stations about their ecological harmlessness, the opposite is the case. It is true, that hydroelectric stations do not pollute the atmosphere. But, on balance, hydroelectric stations inflict much greater economic and ecological damage upon society and nature. The construction of every new hydropower station inevitably leads to the excavating of reservoirs whose number today exceeds 3,500. In the Volga basin alone, 14 large and hundreds of small such reservoirs have been built, thus completely changing the water regime of the river. The cascade of hydroelectric stations has enlarged the water plane of the Volga about seven times over. The normal flow of the river has been upset, thus disrupting its normal water exchange and causing stagnation in many sections of its course. Evaporation has become much more intensive, weakening the ability of the Volga to keep its waters clean, and causing the quality of the water to deteriorate. All that has reduced its fish productivity and its recreational value. A similar situation exists also in the Dnieper, the Don, the Ob, the Angara and some other major rivers. The shoreline of the man-made reservoirs in the USSR exceeds the shoreline of the seas around the Soviet Union.

The ecological affliction of man-made lakes is obvious: they just cannot "live" according to natural laws. Their physical and chemical regime is different from that of natural lakes. For example, the water level of reservoirs fluctuates between falling and filling within 3 m on lowlands and plateaus to 50 m and even 100 m (in mountain country), causing abrasive destruction of their shores, landslides and washouts. The temperature of the water surface of large reservoirs (such as the Kuibyshev sea 500 km long) varies from 5° to 10° C. The quality of water in all reservoirs is rapidly deteriorating. Water bloom, the "cancer" of reservoirs, is spreading. The biomass of the blue-and-green algae have reached hundreds of grammes per one cubic metre of water, and in places of their accumulation several kilogrammes per cubic metre of water. Such concentration of algae has caused decay in water bodies, making their water unfit not only for drinking and other domestic uses, but also for industrial needs.

However, the greatest trouble comes from the flooding of vast tracts of land caused by the construction of hydroelectric power stations. This pernicious practice has assumed the proportions of national calamity. According to a conservative estimate, about 7.5 million hectares of land are today under water. It must also be kept in mind that the total area of ruined lands is at least 15 million hectares, since much of it suffers from rising ground waters and soil subsidences which renders them useless. One must not ignore the fact that the worst hit are the more precious lowlands which can restore their fertility in the natural way. The flooding of river plains has inflicted a heavy blow at the production of feed and consequently at livestock breeding. There are only seven million hectares of river plains left in this country. Feed production has thus been moved to arable areas. As a result, more than 11,000,000 hectares of irrigated and ameliorated lands, i. e. one third of their total area, are under feed crops. One must bear in mind that river plains and grasslands yield up to 50 and even 60 centners of feed per hectare, whereas the yield of feed crops grown on ameliorated soil is half and even one third as great. Their production costs are twice, if not three times, as high as on river plains and grasslands. According to the most conservative estimate, the productivity of these lands is 40 per cent higher than the average crop yield on arable lands. Consequently, as the result of extensive hydro-construction, the country has lost a total of 21 million hectares of land reckoned in terms of the average productivity of cultivated lands. According to our estimate, the total loss to the Soviet state from this one source of waste alone is worth over 600 billion roubles. The casualties list would not be complete without the heavy loss of fish on the spawning grounds which are by turns flooded and stay empty. Besides, fish migration is often disrupted by the high dams.

Reservoirs formed on flatlands are particularly damaging to agriculture. The Tsimlyanskaya storage lake on the River Don, with a power capacity of a mere 165,000 kw, has flooded a huge area of 270,000 hectares of the most fertile land, with their meadows and fields, orchards and vineyards. Added to this is the loss of some unique monuments of ancient Khazar and Scythian culture. The 312,000 kw Kakhovka hydroelectric station has claimed 215,000 hectares of rich, fertile Ukrainian black soil. As hydroelectric stations grew in size and power, the neighbouring flooded areas expanded, too. The Kuibyshev storage lake has buried 600,000 hectares under its waters, and the Bratsk Hydro 550,000 hectares of excellent farmland.

All this massive flooding was accompanied by the transmigration of large numbers of people and by the loss of dozens of towns, and hundreds of villages, the loss of numerous monuments of history and culture.

The reasons for the building of high dams in the 1930s and the 1950s could at least be explained. The Soviet Union was badly in need of electric power. At the same time our industry could not build large thermal power stations, while nuclear power engineering was making its first steps. Our knowledge of ecology was still rather limited. Today the situation has changed. However, even now Minenergo continues its old and pernicious practice of building mammoth hydropower stations. It is true, though, that over the past several years such construction is carried on mainly in piedmont and mountaineous areas and needs no large areas to be flooded. For example, the Tsimlyanskaya Hydro has 1,640 hectares of land flooded per one thousand kw, the Kakhovka station 700 hectares, the Kuibyshev station 270 hectares, and the Nurek station (in the mountains) a mere 5 hectares.

However, the Ministry for Power Industry is still building hydroelectric stations on flatlands. Work is underway on the construction of the Cheboksary Hydro. When the reservoir rises to the expected water level mark, it will flood 230,000 hectares of valuable soil. The Turukhansk Hydro is another example. Upon its completion the flooded area and the area of underflooding will assume truly gigantic proportions. Suffice it to say that the newly formed reservoir will be 1,100 km long.

Not all is well with the building of hydropower stations in mountainous areas. For example, the construction of the Katun Hydro and the Chemal Hydro in the Altai Mountains is ill-conceived, economically senseless, ecologically and socially harmful. Incidentally, neither station was submitted to the state expert commission for approval. The planned power capacity of the Katun Hydro was 1,600 thousand kw, whereas the guaranteed estimate was not more than 400,000 kw. Gidroproekt is trying to justify the idea of building the Katun Hydro (also of the whole cascade of such stations on the Katun River) by the alleged need to increase their peak power. However, this sounds very much like a lame excuse. In the power-grid of Siberia where 56 per cent of electricity comes from hydroelectric stations, there is an excess of peak power and a shortage of base-load thermal power stations. This situation is the result of the fact that hydroconstruction in Siberia was rushed, whereas the construction of thermal power stations run on fossil fuel was held back in every way. It has been proven that over the next 8-10 years Siberia's power industry will not need any additional peak hydroelectric stations.

The building of the Katun Hydro and the Chemal Hydro in the Altai Mountains, with the inevitable flooding of the valleys of the Katun River and its tributaries flies in the face of the rational development of production forces of this unique region. The implementation of this project will lead to irreparable economic, ecological, social and even moral losses. The stations will destroy an area with great recreational, historical and aesthetic potential, an area that is unique in Western Siberia. The stations will destroy the Chemal recreational zone of national importance. It will also reduce the so far good travelling opportunities. The rare natural complexes are losing much of their beauty, the unique flora and fauna of the Katun Valley and its tributaries are deteriorationg because of flooding, whereas in the Ob basin the threat comes from its possible desiccation because of the low flood level. These factors will drive the native population of the region from the valley, will destroy the customary way of life of the ancient Altai people, and their unique cultural monuments. And this will, in turn, exacerbate the problem of conservation of their cultural, historical and ethnical identity. This by far is not the full list of losses that the hydroengineering project on the Katun is fraught with.

As for the supply of electricity to the Altai region, it could be carried out much more effectively through the joint electric power grid of Siberia where it is not used up in full. At the same time the inner regions of Altai could draw electric power from automated, highly effective diesel power stations, and also by operating electric power stations run on wind, and solar energy stations, from small hydropower stations on the tributaries of the Katun. This would serve the needs of the local livestock breeders, hunters, geological parties, holiday hotels and guest houses much better. These recreational facilities must be the main specialty of this region, something Gidroproekt does not take into account.

So, we still have the old departmental, cost-intensive approach to overcome which is the first condition of perestroika.

The *third* argument of the power engineers is plain unconvincing: the building or modernisation of navigable river systems through the construction of reservoirs. Under two per cent of total freight transportation in the Soviet Union falls on river vessels. Moreover, the bulk of deliveries by boat is carried out on the free-flowing rivers of the eastern part of the country. Mountain rivers are not used for freight transportation. Thus to say that one of the reasons for the building of hydroelectric stations is freight carriage would be incorrect.

What are the ways to reduce the adverse effect of power industry on the environment? There are several such ways which, for a better effect, should be used in combination.

First, it is important to equip thermal power stations with effective purifying installations in order to keep the fuel and outgoing gas clean. The method of such purification is well known and it has proved its worth very well. The most common pollutant coming from thermal power stations is sulphur dioxide. Every year at least 20 million tons of this substance are discharged from thermal power stations alone in this country. When its concentrations are sufficiently high sulphur dioxide is damaging to the health of people and animals, to farm crops, and reduces the productivity of commercially used forests. What is more, sulphur dioxide wears down metal structures, machines and installations. Ironically, if trapped, this dangerous pollutant can be turned into a valuable initial product for obtaining sulphuric acid and crystal sulphur the demand for which is growing all the time.

Incidentally, the Soviet Union is the first country to have developed the technology of trapping and using sulphur dioxide. Back in the 1930s, successful experiments were made at the Kashira thermal power station near Moscow to trap this substance. In the 1950s an experimental installation was build at the Moscow thermal power station No. 12, which extracted over 10,000 tons of pure sulphur dioxide from blue gas. Similar and even more powerful aggregates are in operation at the metallurgical plant in Magnitogorsk and at some other plants. At mineral fertilizer plant in the town of Voskresensk near Moscow, and at some other chemical plants, outgoing gas began to be used in the late 1970s for production of valuable chemical substances worth several million roubles annually.

It takes but 3.5-4.0 years (against the industrial average of 8 years) to recoup the expenses through obtaining additional products and by reducing the damage from air pollution. The economic effect from waste-free technology can be illustrated by the following example. If all the thermal power stations were equipped with gas-purifying installations, the sulphuric acid thus obtained would meet half the needs of the Soviet national economy for this chemical. This is particularly important today when about 45 per cent of solid fuel is sulphurous coal the burning of which produces a large amount of sulphur dioxide.

Another aspect of the struggle against air pollution with sulphur dioxide is a more sparing, economic expenditure of fuel. Over the past seventeen years the thermal power stations have reduced the fuel rate expenditure per kwh of electricity from 367 to 326 grammes of equivalent fuel, i. e. by 10 per cent. Alongside the more economic use of coal, there is also a marked reduction in the harmfull discharge into the atmosphere, and consequently less damage from pollution. The possibilities here are truly great. At the Kostroma thermal power station, the fuel rate has been reduced to 317 grammes. If all thermal power stations ever reach this level, the result would be tantamount to a reduction in the discharge of sulphur dioxide into the air by a million of tons. It has been calculated that the extra expense that the introduction of new technologies require get recouped very soon.

Great possibilities can still be derived from making hydroelectric stations ecologically safer. Our country has great hydroelectric potential, with only a small part of it put to commercial use. In Canada, by comparison, 40 per cent of the hydroelectric potential is being used, in the United States 45 per cent, in Italy 70 per cent and in Japan 90 per cent, in Switzerland 99 per cent, whereas in the Soviet Union a mere 20 per cent. As you see, we still have most of our hydroelectric potential unused. Actually, the question is not whether we should build hydro-power stations or stop their construction altogether. The problem is how to build such hydroelectric stations without economic and ecological losses to society and nature. The answer is suggested by our own experience and that of other countries. In the USSR the prevailing trend is for the building of large and giant hydroelectric stations, and not such small stations. Meanwhile small hydroelectric stations can successfully compete with large power stations, primarily because their construction does not require the building of huge water storages that take up large areas of land and disrupt the ecology of rivers.

Norway offers a good example in this respect. It has none of the hydroelectric giants like ours on the Volga and in Siberia. Nevertheless, Norway generates 4.5 times as much electric power per capita as the Soviet Union. In fact Norway holds first place in the world in this respect and at the same time has the biggest share of energy produced by hydroelectric stations. Norway is no exception in this respect. The United States, Canada, Japan, Czechoslovakia, and Bulgaria have somewhere between 30 and 50 per cent of electricity generated by small hydroelectric stations. Every year up to 1,500 requests are made in the United States for building small-sized hydroelectric stations. In China, today, about 100,000 such stations are already in operation.

We must say that before the Second World War small stations were built and exploited in this country, especially on small mountain rivers. To this day 17 such small stations are operating on the Kola Peninsula. These provide the needs of the Murmansk region and the Karelian Autonomous SSR. Back in the 1950s and 1960s many collective and state farms of the Altai Region had their small hydroelectric stations. Over the past 15-20 years they have been abandoned, many of them destroyed, thus creating a shortage of electric power. To make up for this shortage by building large power systems in the mountains would be impossible. Scientists in Kazakhstan have started work on a complex, integrated system of small hydroelectric stations to be built in the Altai Mountains. The realisation of this project will provide a good alternative to the building of the ecologically harmful Katun cascade of large hydroelectric stations. Soviet engineers have developed new types of turbines and power generators for small stations, including those that will need neither massive structures nor dams across rivers. A good example in this respect is the experience of Soviet Georgia. The scientists of the local institute of power engineering and hydrotechnical installations have designed a small hydroelectric station of 1,300 kw. Notably, this station will operate on the effluent from purifying installations in Tbilisi and Rustavi. The project will serve not only power generating needs, but also the needs of nature conservation. For example, a head-pond will reduce the concentration of pollutants in the purified effluent by 20-25 per cent, and the temperature of the water discharged into the River Kura by 40-45 per cent. This will help use the head-pond for fish-breeding. The new station is expected to have a high economic effect. The cost of production of one kwh is a mere 0.6 kopeks, and the cost of construction will be recouped in 1.3 year.

Nuclear power engineering merits special attention. In 1987 Soviet nuclear power stations generated 181 billion kwh a year, which is a little under 12 per cent of the total amount of electricity generated in the country. Until recently the more ardent advocates of the speedy development of nuclear power engineering forecast that by the year 2000 about half of the total electric power would come from nuclear power stations. Today life has made some important adjustments in these prognostications. Today, the International Atomic Energy Agency estimates the proportion of nuclear energy in total power production at 15-20 per cent by the end of this century.

One of the most common explanations for the speedy development of nuclear power engineering is the contention that nuclear power stations produce less pollution than thermal power stations. In our view this is not correct. In the first place these nuclear stations are far from being harmless, especially if one takes into account the problem of burial and decontamination of radioactive waste. According to some estimates, by the year 1995 the Western countries alone will have accumulated 55,000 tons of radioactive waste, and by the year 2000 this amount will have reached 125,000. Recycling technologies are expected to be developed only in 1992-1995.

Second, ecologisation of nuclear energy is rather problematic in that the building of the most technically perfect nuclear power stations by modern standards does not guarantee against environmental pollution, because none of them are foolproof enough, and therefore do not rule out the possibility of accidents. It is necessary to keep in mind that there is no absolute safety in any area of human activity, much less in the sphere of modern industrial production. Therefore, it is quite obvious that the greater the scale of production, the greater the possibility, with all other conditions remaining the same, of accidents. Our nuclear scientists and engineers have over decades been lulling public opinion by trying to convince themselves and others that nuclear power stations are absolutely safe. The Chernobyl tragedy dispelled this myth. As was emphasised at the meeting of the Political Bureau of the Central Committee of the CPSU on January 14, 1988, the direct damage alone from that accident cost the nation 8 billion roubles. But how to calculate the full scope of human tragedy, the disruption of the existing life style, the migration of people from their homes, the exclusion of vast areas from economic use after nuclear contamination. Here we can see the dialectical law of transformation of quantity into quality at work. In this case this new "quality" is not only negative but indeed dangerous to human life. In 1954 there was only one atomic power station in the USSR, the one in the town of Obninsk, near Moscow, with a power capacity of 5,000 kw, whereas today there are 45 nuclear reactors with a total power capacity of 34.4 million kw. Many nuclear giants, notably the nuclear power stations in Leningrad, Kursk, Smolensk, have the same HPOR[1] type of nuclear reactors as the one in Chernobyl. There are eleven more nuclear power stations being built in addition to the ones already working. It goes without saying that the growing number of nuclear reactors enhance the hazard of accidents. Quite naturally, nuclear technology, just like any other technology, is developing and is getting more and more refined. Any further development of nuclear power engineering in our country, and the building of new nuclear power stations will rest on more foolproof water-cooled and water-moderated reactors. And yet the quantitative growth of nuclear reactors, like any other major establishments in mining, metal smelting and chemical industries have an increasingly dangerous and even destructive effect on the environment, on people's health and their well-being.

The problem of the structure of nuclear power engineering and its expansion is so important that we should dwell on it in greater detail.

What is "nuclear power engineering"

The term nuclear power engineering covers the full range of methods (both existing and those under development) of generation of electrical (also thermal) energy whose source is the energy of the atomic nucleus.

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[1] HPOR—the abbreviation of high-power output reactor.

At present more than 99 per cent of all electric power generated at nuclear power stations is generated in reactors operating on thermal neutrons. These power stations could be called nuclear power stations of the first generation. More than thirty years ago, the Soviet Union, for the first time in the world, placed into service a nuclear power station operating with a reactor of this type, and ever since nuclear power engineering has been developing on the basis of thermal neutrons.

In addition to that, there are several breeder reactors (operating on fast neutrons) which inaugurated the second generation of nuclear power stations.

And, finally, the third generation of thermo-nuclear reactors, operating on the basis of thermo-nuclear reaction, which exist only in theory.

We do not want to go into technical details and the problem of economic expediency for now, and will only say that the principal requirements of power stations of any kind are 1) security and safety in the broad sense of the word (which amounts to a complex effect on the environment) and 2) guaranteed fuel supply.

From this point of view the nuclear power stations of the third generation are the most attractive of all, because they are both ecologically clean and have practically unlimited energy resources.

The nuclear power stations of the second generation have no fuel problem, since they actually produce more fuel than they expend. However, the safety risk is still fairly high.

As for the nuclear power stations of the first generation, they have no advantage over conventional thermal power stations run on fossil fuel. However, there is a problem here that we would like to discuss in detail.

And now for the safety problem. However strange it may seem but the Chernobyl accident has made it much more difficult to write about this. Hindsight is always better than foresight. Of course the author of this book, together with many others, could not have possibly expected that a thing like this would happen. How could one expect the personnel of the Chernobyl nuclear power station to make six major mistakes. Let's hope that this will never happen again, especially bearing in mind that all nuclear reactors will, from now on, be equipped with special blocking systems against even the most incredible human errors, in accordance with the Soviet proposals for new safety regulations.

However, the main hazard, should nuclear power stations of the first generation be in common use across the world lies elsewhere.

Nobody can rule out that a political conflict in the modern world will not develop into an armed conflict, where nuclear weapons may not even be used. In this case a country with many nuclear power stations operating on its territory would be particularly vulnerable because the enemy can achieve radioactive contamination of its territory by using conventional weapons against these nuclear power plants. It has been estimated that the complete destruction of a reactor operating on thermal neutrons with a standard capacity of 1 million kw could have the same disastrous effect as the explosion of an atom bomb of 1,000 kilotons.

Besides, the fuel for a nuclear power station has to go through several stages of processing and enrichment. In one of the links of this chain, the nuclear fuel can easily be used for the manufacture of a home-made atom bomb. Thus, should this fuel be pilfered the chances are that it may be used by some extremist and terrorist groups.

Some ten years ago, Aurelio Peccei, celebrated humanist, President of the Club of Rome, wrote: "I am more pessimistic and radical than my scientist friends in judging the nuclear solution—which is represented for the moment by the fission alternative only... I cannot imagine that this same society will be in a condition, within a couple of decades, to safely host and protect several thousand huge nuclear power stations and to transport across the planet and process every year quantities of the deadly plutonium-239 tens of thousands of times greater than what it would take to kill all the people living today."[1]

Today, in spite of the fact that the question of safe delivery of fuel is on the list of the Soviet proposals submitted to the Atomic Energy Commission, the very concept of "nuclear terrorists" sounds incredible if applied to the Soviet Union. But let's not flatter ourselves. We are not living in the clouds, but in "our common home" called the planet Earth, and shall not be able to completely isolate ourselves from the miasmas that contaminate the atmosphere of the world community. After all, a mere 25-30 years ago such problems as drug addiction, prostitution, hijacking of aeroplanes and bomb scares sounded equally incredible.

Now energy resources. First generation reactors use under 2 per cent of the energy contained in uranium, whereas the reserves of this mineral are as limited as the reserves of any other mineral fuel. Thus the fuel problem of nuclear power stations is very little different from that of supplying fuel for conventional thermal power stations. It is true, though, that the operation of nuclear power stations require much smaller volumes of fuel (as compared with thermal power stations run on coal) and in this respect they hold considerable cost advantages. But who can determine the cost of safety (considering the possibility of stealing) in the transportation of nuclear fuel? And is such absolute safety possible? Some day the cost of such transportation may become so high that nobody would be able to measure it in roubles.

And yet, maybe the nuclear power stations of the first generation hold some important economic advantages over conventional thermal power stations? After all, the expected economic benefits stimulated, back in the 1960s, the development of nuclear power engineering abroad. In those days, long before the sharp rise in the price of oil in 1973 (i. e. before the world energy crisis), there were no other incentives for the development of nuclear power stations.

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[1] Aurelio Peccei, *The Human Quality*, Pergamon Press, Oxford, 1977, pp. 122-23.

The rapid construction of nuclear power stations in the capitalist countries continued until the mid-1970s. At that time specialists in the West were strongly in favour of nuclear power stations in view of the expected financial gain. However, the long experience of their building and exploitation has shown that the actual cost of electric power generated at modern nuclear power stations is a far cry from the initial calculations and in many cases is even higher than the cost of the electric power generated at coal-operated thermal power plants. For instance, in the United States (depending on the region and consequently on the price of coal) the correlation between the cost of electric power generated at nuclear power stations and at thermal power stations changes, giving preference to one or the other in different states. On the whole the cost of power generated at nuclear power stations has over the past several years been about 20 per cent higher than that generated at coal-operated power stations. In European countries, as a rule, nuclear power stations are more cost-effective than other types of power production. The cheapest electric power is generated at nuclear stations in France. Its production cost is 25-30 per cent lower than that generated by coal-operated thermal power stations.[1]

Significantly, estimates of the cost of power production at nuclear power stations are made without consideration being given to the expense involved in the burial of radioactive waste or to the cost of dismantling old and played-out stations. Besides it is not yet known how much more the cost of electric power will rise after safety precautions have been taken at nuclear power plants.[2]

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[1] In the Soviet Union the cost of electric power production at nuclear power stations in the late 1970s and the early 1980s was fairly low, but it was higher than at conventional thermal power stations. On his part the former Minister of Energy and Electrification of the USSR, Alexei Mayorets, claimed that nuclear power stations operate "at a lower cost and in some cases at a much lower cost".

[2] "The discussions held at the Atomic Energy Commission resulted in the development of fifteen recommendations whose realisation would still further increase operational safety at nuclear power stations"

The very principle of operation of nuclear power stations on thermal neutrons rules out their wider utilisation in the future. This is the dead-end of the evolution of nuclear power engineering. Just like the development of civil aviation would be impossible if it were based on the Montgolfier balloons, so would the nuclear power engineering of the future if it were based on thermal neutrons.

However, if we look at it the other way, just as air balloons were an important stage in the history of aeronautics, so the nuclear stations of the first generation and the experience of their exploitation are the indispensible link in the development of nuclear power engineering. The question is how many nuclear power stations we need.

Before we continue with this important problem, let's see

How nuclear power engineering is developing abroad

Early in 1987, the combined power of all operating nuclear power stations in the non-socialist countries was 228 million kw. Now, is it a lot or is it a little? To answer this question we must, as usual, know exactly what we are comparing it with. If we compare it with 48 million kw which was the combined power capacity of all the nuclear power stations that those countries had in early 1974, then, of course, the five-fold increase we just cited sounds very impressive. This figure, compared with what was originally planned, is only one-fourth of the planned capacity.

Of all the advanced capitalist countries, the United States took a particularly negative view of the use of nuclear power stations of the first generation. Today all countries (of the non-socialist world) that generate atomic energy have fewer and fewer nuclear power stations, both operating ones and those that are still on the drawing board, whereas one third their number (including Sweden, Austria, West Germany, Britain, Spain, and the

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(from an interview with Academician V. A. Legasov. *Pravda*, September 5, 1986).

United States) are neither building nor have orders for the construction of new nuclear power stations.

Characteristically, as time goes on, each new prognostication made outside the Soviet Union shows fewer and fewer nuclear power stations to be built by a certain date in the future. For example, over the past twelve or thirteen years western estimates for the year 2000 are 10 or even 15 times lower. Some prognoses made in 1974, put the combined power of all the nuclear power stations of the non-socialist world by the end of the century at 3,500-5,000 million kw, whereas today this figure has gone down to 300-350 million kw. Thus the absence of expected economic advantages, alongside with considerable technical and ecological problems, have prompted the advanced capitalist countries to freeze or sharply reduce the programmes for the construction of nuclear power stations operating on thermal neutrons. This was also largely prompted by still another circumstance that we should pay special attention to. Already in the near future the problem will arise of what to do with the nuclear power stations that have completed their service life, which, incidentally, does not exceed 30 years. It is easy to see that already early in the next century — in the year 2001-2010 — two thirds of all nuclear power stations — both those in operation and under construction — will have to be "retired". This sure is no easy problem, because to halt the work of a nuclear reactor is by far not half the job done. The main problem is to make sure that the outgoing nuclear station is safe for both the population and the natural environment. And this provides the total removal of all the radioactive materials from the area of and around the nuclear station after its termination. Radioactive contamination must be brought down to a safe level that would enable the unlimited commercial use of the site of the station. And this means that at the initial stage of its liquidation the personnel directly involved in the dismantling job may receive a massive dose of radiation. This also involves high outlays and the need for a fairly large area for accommodating the radioactive waste. Plans are afoot in the United States for dismantling the first nuclear plant reactor Shippingport-1. This reactor of the RWR type has a capacity of 60,000 kw. The reactor's equipment and the radioactive materials are expected to be removed within $4^1/_2$ years. According to calculations, the cost of the dismantling of a standard 1 million kw reactor takes about six years to complete, involving some 42-52 million dollars. Moreover, these expenditures tend to grow rapidly and are expected to double, thus constituting about 20 per cent of the entire building expenses of the station. It is necessary to earmark large material resources, including financial, for withdrawing nuclear power stations from service long before its time has come. Incidentally, discussion is underway in the United States about raising the price of electricity by 10 per cent for meeting the expense of the dismantling operation.

Regrettably, the leading officials and the design organisations of Minatomprom (Agency responsible for nuclear power engineering) apparently do not take proper notice of these important facts.

In spite of the faulty performance of nuclear power stations of the first generation all over the world, the Soviet Union ignored the fact that almost all the advanced capitalist countries had scaled down the building of such stations. What is more, the Soviet Union launched a programme for the speedy development of nuclear power stations operating on thermal neutrons.[1]

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[1] This raises a question that transcends the scope of nuclear power engineering. Who takes decisions on the key aspects of this country's development?

Any schoolboy knows that the sole prerogative of decision-making on all important questions rests with the Supreme Soviet of the USSR (the Soviet Parliament), and the Central Committee of the CPSU. Let's pause and think of how the decision-making process works. It is true that all important plans are *discussed* and *endorsed* by the leading party and government bodies. However, the documents and other materials that are subject to such discussion and endorsement are *prepared* by groups of specialists who are believed to obtain and pass along objective and reliable information.

It often happens, however, that such information is slanted or plain false. There are two reasons for this:

Where have we got that idea that nuclear power industry is growing apace all over the world?

Until recently the idea was prevalent outside the Soviet Union that nuclear power stations of the first generation had certain advantages (including economic advantages) over all others. There is nothing surprising about it, considering the tremendous funds invested in the West, notably in the United States, to make such stations work. Hence the question of how to utilise the already existing power generating capacities, and also whom to sell nuclear reactors to. In this connection, one can easily understand why certain vested interests are so anxious to paint nuclear power engineering in rosy colours.

It is not yet clear why Soviet publications did not take a critical view of the progress of nuclear power engineering in this or any other countries. Soviet estimates of the future of nuclear power engineering were (and still are) in many cases much more optimistic than the most enthusiastic prognostications made in the West. For example, Academician A. Alexandrov said in 1976 that at the end of this century all nuclear stations throughout the world would generate a total of 2,000-4,000 million kw, whereas the International Atomic Energy Agency and the World Power Conference put their estimate at 2,000 million kw.[1]

Academician V. Legasov once said that one million kw of installed capacity at a nuclear power station could save about two million tons of liquid fuel a year. In practical terms the opposite is the case.

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1) The narrowly departmental thinking of our specialists, the result of growing specialisation in all fields, which is typical of modern civilisation. In this connection, any data presented by narrow specialists cannot be "objective for purely objective reasons".

2) The practical interests of individual groups of scientists and specialists. These interests not only consolidate their unobjective, biased approach, but often lead to outright distortion of facts. The fallacious practice of padding and falsifying information has also penetrated into the sphere of science. No need to say that it is a lot more difficult to expose such acts of cheating in the field of science, than, say, in cattle breeding and cotton-growing.

[1] It is now clear that this power capacity will stay within 500 million kw, and that only if half the amount is provided by the CMEA countries.

So, in the first place, this is not 2 million, but 1.3 million tons; second, to be exact, it is not any liquid fuel in general, but residual fuel. And, third, this contention holds true not only in the case of a nuclear power station but any electric power station with a capacity of one million kw, given the same conditions of exploitation.

It is true that only those make no mistakes who do not do anything. But when there are too many mistakes, and all of them are slanted one way, and not the other, the reader begins to feel that somebody is anxious to present the subject of discussion in a certain light.

There have always been influential forces which have a stake in one project or another (which later is recognised as erroneous and even harmful). Each time those who represent these forces use arguments which on the face of it sound quite sensible and even convincing to the layman. On the other hand, there may be other points of view and other arguments. And since the opponents in this controversy have never been given a say in the matter, all these arguments have been aired in "private" discussions, very often in the corridors of the very same institutions and organisations which have played a part in the adoption of "epoch-making" engineering projects.

The advocates of the galloping drive of nuclear power engineering do not so much as try to defend the validity of the figures in their absolutely irrational and unrealistic plans (surely it is impossible), and do not try to put these figures on a sound economic basis; their main efforts are directed at discrediting and frustrating any attempts to comprehend prospects for nuclear power engineering in our country. The same is true of the projects of redirecting the flow of our northern rivers.

If there was a grain of realism in these projects, then the plans for, say, the development of nuclear power engineering for the 12th five-year plan were not what they are today.

In the 12th five-year plan period (1986-1990) 41 million kw of nuclear power capacity are expected to go into operation. This, however, is impossible because, among other things, the construction of one power-block with a capacity of 1 million kw would according to standards take 60 months to complete... In addition, the selection of the building site and all the necessary technical and economic calculations would take another seven years. This means that to launch 41 million kw of power capacity before the year 1990, all these capacities must, as a minimum, be ready for the construction stage before 1985. In actual fact only half these capacities were ready at the beginning of 1986.

By 1990 nuclear power stations are expected to generate 390 billion kwh. Take a good look at this figure: not 400, and not 350, but 390 kwh as if to suggest the exactness of calculation and economic substantiation. But ... take a look at Table 6.

Table 6

Nuclear power stations in the USSR	1980	1987	1990 (plan)	Growth over llth five-year plan period	Growth over 12th five-year plan period
Installed power capacities (million kw)	12.5	34.4	69	15.5	41
Production of electric power (billion kwh)	73	187	390	94	223

One does not need to be an expert to understand that the figures for 1990 were entirely fictional. All you have to do is to correlate the growth of production of electricity and the growth of power capacity and see that these two quantities for the 11th and 12th five-year plans are at variance with one another.

During the period of 1981-85 the growth of power capacity measuring 15.5 million kw assured a growth of power production by 94 billion kwh, whereas in the current five-year plan period the launching of a combined 41 million kw (some sources give an even more precise figure — 41.5 million kw) will increase power production by 223 billion kwh. This means that in the 11th five-year plan period (1981-1985) the per unit accretion of power production was 6,000 kwh, whereas in the 12th five-year plan period (1986-1990) such production was for some reason reduced considerably down to 5,400 kwh. Could it be that this reduction signalled some serious problem? Nothing of the kind. What happened is that the economic plan was not properly edited. But should anybody bother to edit it, if, in the eyes of its authors, this is nothing but an exercise in arithmetic? Long before the adoption of the planned assignments for the 12th five-year plan, the officials and specialists at Minenergo and Gosplan knew very well that to reach a 41 million kw power capacity in the year 1990 they had neither enough construction underway, nor the funds to invest for this purpose. In other words, they knew that the state plan would be scuttled. So what? That was not the first time such things had happened. During the last five-year plan period, a mere 15.5 million kw were added to the existing power capacity, instead of the scheduled 24 or 25 million kw.

After years of readjusting planned assignments officials and indeed whole organisations have learned how to play around with figures in long-term and even five-year planning.

Each time they readily provide excuses for the failure to meet the planned targets blaming circumstances for their own poor performance. This, of course, is a bureaucratic ploy. Everybody understands that in our fast-moving age one cannot foresee everything, and what was not clear yesterday becomes obvious today, and that adjustments in planned targets are unavoidable. Adjustments — yes! But not completely new targets. When their fulfillment adds up to half of what was expected, what would you call this other than failure, outright failure. That, of course, when one treats production plans seriously, and not as sedatives for the top authorities.

The main thing here is that all but yesterday, when these plans were approved prior to their adoption the "initiated" knew very well that these planned targets would not be met.

As for nuclear power engineering, all persons concerned could hide themselves under the "Chernobyl umbrella", that, is the slower rates of nuclear power plant construction due to additional work to make the plants more safe, but they do hardly need it. They know very well that nobody will ever ask them: "And what about delivering on your promise? Why were you silent, knowing full well that the planned targets were unrealistic?"

In particular this is illustrated by the fact that, today Soviet plans for electricity production in the year 2000 are actually the same as what we planned back in the early sixties for 1980. Remarkably, the same officials under the same minister adopted both plans.

Back in the last century a man who had gone bankrupt shot himself and he who did not keep his word was sent to Coventry. But those days are gone, and today, a whole team can ruin one programme after another without feeling any prick of conscience.

This is an example of how, prior to the Chernobyl disaster, problems of safety at nuclear power stations were presented to the reader. A newspaper article whose main conclusion was epitomized (in the words of the author) by the idea that Shakespeare voiced in Heecate's line: "And you all know, security is mortals' chiefest enemy",[1] contended: "Nuclear power installations are designed and built so that the population around does not suffer physically not only when they operate in the normal regime, but also when accidents are precipitated by an earthquake or, most incredibly, by an aeroplane falling upon the reactor." Further on the article reads: "Of course specialists know that it would be impossible to set off a nuclear explosion at an electric power station. It is only a sheer coincidence of circumstances that can lead to something like an explosion no more destructive than an artillery shell."

Dostoyevsky said that "the feelings of guilt always linger on the Russian intellectual". If we agree with Dostoyevsky, we must admit that no such intellectuals exist among the "power administration", to say the least.

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[1] William Shakespeare, *Macbeth*, Act Three, Scene V, pp. 23-24.

A good illustration of this is the Chernobyl disaster and the consequences. The true facts, without attempts to explain everything by the "fateful superimposition of technical faults", came somewhat later, after the ad hoc meeting of the Political Bureau of the Central Committee of the CPSU. Moreover, the information about the disaster is still given to the public in an incomplete and embellished form.

Another example of how a group of "experts" can fool everybody, and primarily the high authorities is the Long-Term Energy Programme of the USSR.

This document which was adopted (without much public discussion) in 1984 is to be revised because of its unsoundness. Suffice it to say that already in the Guidelines for the Economic and Social Development of the USSR for 1986-1990 and for the Period Ending in 2000 whose draft was made public a mere eighteen months after the "Energy Programme", the rates of reducing the energy intensity in the national income — the principal indicator that sums up all the activities under the current energy policy — was planned to be increased almost four (!) times.

The Energy Programme gives the impression that its authors set out to apply all modern world trends in the development of power industry to our Soviet conditions, all of which were put upside down. This can be illustrated by the power industry.

The typical features of the development of this industry abroad over the past 8-10 years were:

a) the sharp slowing down of the building and launching of nuclear power stations of the first generation;

b) the less enthusiastic attitude to "new" methods of power production, including fast reactors and to thermonuclear synthesis;

c) renunciation of gigantism — the growth of unit power;

d) more attention to the quality of electric power;[1]

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[1] This concept denotes reliable, continuous supply of electric power, with much attention paid to frequency of oscillation, stability of

e) considerable growth in the effectiveness of utilisation of electric power.

But in the USSR the above trends have the opposite direction, whereas the Energy Programme recommends that they be maintained until the year 2000. Here is an itemised list of these recommendations:

a) The USSR planned to place into service over the coming 20 years a total of about 200 million kw of power capacities with thermal reactors. By comparison: in the whole of the non-socialist world over the period of 1986-2000 nuclear power stations with a total power of about 100 million kw will be put into service mostly by way of the power stations already under construction which were projected back in the 1970s.

b) Interest abroad in fast reactors has gone down, mainly because of the technological and economic problems (at the world's largest reactor in the Super-Phoenix series in France, the cost of electric power is twice as high as at lower capacity nuclear stations). No progress has so far been made to move the work in the sphere of controlled thermonuclear fusion out of the laboratory. The lack of demonstrational experiments has delayed the expected production of electricity for industrial needs in this way until 2015-2030. According to the Energy Programme the USSR will in 1990-2000 create a pilot-commercial plant of controlled thermonuclear fusion. This is a fantasy, and not even scientific at that, because, as is well known, there is a great distance between demonstrational experiment and a commercial plant.

c) It became clear by the mid-1970s that the technological difficulties in the manufacture, installation and exploitation of super-power blocks do not match up the economic advantages derived from their exploitation. This has created a situation in which over the past 15 years the average size of thermal power stations in the United States, for example, remains constant at about 500,000 kw. Nuclear station unit power is not growing any more either. What is more, lately the spotlight has

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voltage in the conditions of diurnal and seasonal fluctuations in electricity consumption.

been put on prospects for the development of mini-hydro-electric stations and nuclear power stations with 150-200 kw reactors, etc. As for the Soviet Union, it is still bent on gigantism. For example, the world's largest nuclear reactor of 1.5 million kw has been installed at the Ignalina nuclear power station. No more reactors are planned to be commissioned here but the Energy programme provides for more power units be put into service with reactors of 1.0 and 1.5 million kw by the year 1990.

d) The Energy Programme provides for the use of a higher quality of electric power. But it does not say how this will be achieved. What we can expect is further deterioration of its quality because not enough old and obsolescent equipment is being replaced leaving more and more ineffectual and obsolescent power units in service.[1] Moreover in the European part of the USSR where a number of nuclear power stations are expected to be installed, there is a growing shortage not only of electric power capacity in general but also adjustable (peak) capacities in particular. The growing qualitative requirements of electric power cannot be met by introducing more electric power stations designed for base load operation. At present the hooking of a large number of non-flexible nuclear power stations into the existing power grid may only aggravate the power supply situation in the European part of the USSR.

Some Soviet scientists have indirectly noted that. For example, Academician M. Styrikovich and Dr. A. Siniak wrote: "the use of nuclear power stations over and above certain limits, which in turn, greatly depend on local conditions, will entail additional expenses that lower the economic effectiveness of their exploitation". Academician A. Lyulka: "According to the commission for gas turbines of the Academy of Sciences of the USSR, the normal development of power systems of the country over the coming 10 years requires the launching of tens of millions of kw of specialised flexible power capacities—gas turbine and steam-and-gas installations."

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[1] This can easily be judged by comparing the power capacities which were launched from 1955 to 1970 and which are planned to be renewed by the year 2000.

e) The idea of growing electric power intensity of the national income that underlies the Energy Programme does not match up the policy of production intensification. For example, the electric power intensity of the national income is expected to increase by 15 per cent by the year 2000. It looks as if all problems in this country that are geared to the production and consumption of electric power are expected to be solved by the same extensive methods.

In advanced capitalist countries electric power is used much more effectively today than ever before. The growth of social production does not entail increase in the per unit consumption of electricity. The fact is our industry consumes more electric power than American industry, whereas the volume of industrial output in the Soviet Union is smaller than that in the United States.

The question suggests itself: "Why do we have to produce electric (notably nuclear) power?"

The answer seems to be simple: to satisfy the needs of the national economy of this country. As is known, power engineers are working hard to produce the much needed kilowatt / hour of electricity. But maybe we should take a closer look at such concepts as "much needed", and "necessary".

So what is this kilowatt / hour produced for? For using it in industry, in the smelting of steel and aluminium, or for the production of chemicals where per unit consumption of electric power is much higher than any of the existing world standards? Or maybe we produce it in order to lose it in the process of transmission and distribution of electricity? For we lose twice as much electricity in our power lines as do the best power transmission systems abroad. One of the main reasons for this is the shortage of compensatory devices, mainly capacitors. This, in turn, is due to the lack of special film, whereas the lack of film comes from the poor performance of our chemical industry. All that has been going on for decades. Thus it becomes clear that by far not all the kilowatt-hours that our power industry produces are actually necessary.

And what about fuel for electric power stations? After all the principal argument of the advocates of nuclear power stations in the European part of the USSR is the shortage of fossil fuel for thermal power stations in this region. Delivery of, say, coal entails great difficulties, and transportation expenses are growing rapidly. It is widely believed that an increase in coal transportation is economically inexpedient and practically almost impossible.

Of course, when we raise the problem of transportation we must define what we transport and how. In the first place we should carry coal and not empty rock (its percentage is very high). Secondly, it is important to carry coal, and not water (too much moisture in it). Third, what we ultimately want to achieve in the process of transportation is not what we carry, but what we eventually bring to the place of destination (transportation losses are tremendous). The conclusion we thus make is that the same efforts that we expend on coal carriage today could be used much more effectively on the transportation of more coal.

All that is only one side of the problem. The other side is that the same quantity of fuel can be used more effectively in electric power production. Thus, the average national amount of equivalent fuel per I kwh of electricity is 327 grammes, whereas at some power stations this indicator has reached 500 and even 600 gr. Consequently, by burning the same amount of fuel, the thermo-power stations of the Soviet Union could generate a lot more electricity.

As is known, everything can be viewed from different angles. One can, saying that there is a shortage of electricity, insist that nuclear power stations generate the electric power that our country needs so much. But the same problem can be viewed from a different angle, too. We can say that the nuclear energy in our country is used to offset the excessively high (for a developed country) losses in the power mains[1], also the losses from overconsumption of electric power, notably in the manufacturing industry.

This calls to mind analogies with soil amelioration.

It goes without saying that those officials who are in charge of the power industry or of water management find it a lot easier, and also more advantageous, to build a new nuclear power station or dig a new canal rather than try to modernise and update the old equipment, or try to save material and financial resources. In other words, they would rather follow the old way of extensive development of the national economy instead of using more advanced intensive methods.

Upon the completion of any new construction project (especially a large one) they are sure to get promotions, additional resources, bonuses, prizes and government awards. Also such huge construction projects enjoy solid financial backing, many billions of roubles worth of investments and subsidies. Whose money is that? This money belongs to the state, to the people, i. e. it belongs to all of us and yet to no one in particular. At any rate this money does not belong to the top executives of the electric power industry. Otherwise these executives would themselves try to find out which project is easier and cheaper to build, whether they should build a canal and in this way syphon off water from a river or lake, or update the existing irrigation system in order not to lose the water that need not be lost, and which must not be lost, owing to present-day technical facilities.

Many years ago an observant foreigner noted after several trips to the Soviet Union: "You will never have a problem of drinking water. And if ever such a problem does emerge, all you need is to fix the leaking taps in the kitchen and the toilet." Of course, we know all too well that to repair leaking taps in this country is just as difficult as to find an effective medicine for colds. It is still more difficult to supply a country as large as ours with reliable equipment for measuring and controlling the expenditure of water (and electric power). And besides we have never tried to do so. We have no other way out, however. The extensive development of the national economy, and consequently any of its industry cannot go on forever.

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[1] In the USSR such losses are 9 per cent, whereas in the best power mains abroad this figure is 4.5 or 5.0 per cent. For our country 4.5 per cent is about half the entire electric power generated by nuclear power stations.

And finally

How should nuclear power engineering be developed in the future?

Let's draw up a flow chart, outline the principal links of the chain of problems the solution of which will provide the answer to this question in any country:

Principal goals of development of the country
Ways to develop the economy
Power potential and its utilisation
Electric power engineering
Nuclear power engineering

Every country has its own specific features (political, social, geographical and national), and any of the above links can have different directions, and can follow different roads of development.

For example, it would be wrong to say that the only road of economic development in our country should follow the same technical and economic pattern as the advanced capitalist countries. To follow the same direction is only possible when there is the common goal. Our ultimate goal and our ideal to make people happy not only differ from the objectives of capitalist society but are widely at variance with its concept of "building up" more material benefits.

As for energy potential, first, its utilisation must largely be determined by the political system and the social ideals of the country. And, secondly, before using something, the country must have it. Therefore we cannot blindly compare our power industry with that of France or Japan, because these two countries have practically none of the traditional energy resources we have. So if we are to make comparisons, this should be done with countries of a roughly similar energy potential, such as the United States and Canada.

In this respect the position held by the United States merits special attention. Starting with the early 1970s the Americans have adopted a number of so-called self-sufficiency energy programmes. However, to this day very little progress has been made in this respect. A country which has such tremendous energy resources continues to import fuel, especially crude oil. You may wonder why? Very possibly because with the depletion of the world reserves of oil, the domestic oil reserves that the United States will have kept will enhance its economic and political "weight". Apparently the Americans find it advantageous to satisfy their energy needs at the expense of other countries and at the same time conserve their own national mineral wealth.

The strategy of utilisation of energy potential is an important factor behind the development of power engineering in general and nuclear power engineering in particular. An analysis of development of power engineering in the world prompts the conclusion that in the future (somewhere far beyond this century) the energy of the atom will undoubtedly play a major role in the power industry. And this, probably, will be nuclear power stations of a new generation, also installations operating by thermonuclear fusion, etc.

The USSR must, in my view, direct its main efforts and funds over the coming 10 or 15 years, not at the development of nuclear power engineering, but at improving the general situation in the electric power industry. Thus, for example, power facilities are getting increasingly old. Unless urgent measures are taken to replace the obsolete equipment, to remove the power units that have already completed their service life (which is not being done as rapidly as should be and not on the required scale), our energy situation will continue to deteriorate.

With the shortage of funds the construction of costly nuclear power stations will, I think, be economically inexpedient.[1] The allocations for this purpose fall far short of what is necessary to launch the capacities that would in the near future assure the normal functioning of the electric power industry.

The alternative to the existing programme (effective until the year 2000) may be, first, the intensive modernisation or the replacement of obsolete facilities, also the use of flexible equipment, and, second, the introduction of energy-saving measures, particularly a sharp reduction in the losses of electric power that occur in the course of the transmission and distribution of electric power, improvement in the quality of electricity,[2] measures to even out power loading. This entails certain difficulties, but would require only a part of the capital investments directed at speeding up the development of the nuclear electric power stations of the first generation.

Judging by press reports, most power engineers have other ideas on the subject. It goes without saying that problems of power engineering, just like any other sphere of our life, should be made a subject for free and open discussion. In addition to that, as V. Chichkanov, a corresponding member of the Academy of Sciences of the USSR, said "it's not enough to be able to air one's views. It is also important that you be heard out with maximum attention and that your opinion be reckoned with, that it be either accepted or proved erroneous."[3]

One of the last articles written by Academician M. A. Styrikovich bears the title: "Let's not Argue, Let's Calculate".[1] However, in my view, calculations cannot fully take the place of discussion, if only they are an element of this discussion. Each side in the dispute has its own reckoning. Besides, scientists and engineers are not free from making mistakes in their calculations. There are many reasons for it, although these are coming more and more of a pattern, arising from a desire to obtain results that do not contradict the scientific concept of the author, and sometimes from a desire to squeeze such calculations into the Procrustean bed of expediency and time-serving considerations.

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[1] The investments per kw of power capacity at nuclear power stations have always far exceeded the investments in the construction of conventional thermal power stations. With additional measures to promote operational safety at nuclear power stations in this country, the cost of their building is growing and will eventually be about three or even four times as high as the construction of power stations run on fossil fuel.

[2] According to the Science and Technology Committee the losses caused by the poor quality of electric power throughout the country are estimated at two billion roubles a year.

[3] *Moscow News*, August 31, 1986.

This is why it is necessary to argue all questions, including those that seem to be obvious and that most of the leading specialists take for granted. Regrettably, even specialised publications by far not always carry materials that may be even slightly at variance with the position held by the top authorities. Most of the scientists are aware of that and very often write not what they want to but what they may.

Here is another important thing to be mentioned: making new technical systems both reliable and ecologically safe places rigid demands on the quality of building and assembly work, on materials used and on the quality of repairs and modernisation of equipment. The state of equipment must be checked at all stages of its exploitation.

The choice of the building sites of nuclear power stations is another important safety factor. For instance, they must never be built in or near populated areas, in recreation and intensive economic activity zones, at water intakes and in seismic areas. In the light of the above, much attention and support should be given to the proposals of Soviet scientists (among them M. Lemeshev and V. Markov) for the construction of nuclear power stations in unpopulated areas, notably in abandoned open-cast collieries. Some of these old collieries are 300, 500 and more metres deep, and have a firm bed-rock. They may have no near-surface ground water and water-bearing horizons. The area around such collieries is not populated and is of very little economic use (anthropogenic "lunar" landscapes). Should an accident happen at nuclear power stations built in such places, they can easily be buried by directed explosions in the mass of rock and empty waste material that form their banks.

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[1] *Energy: the Economy, Technology, Ecology*, 1986, No. 10, p. 2 (in Russian).

Regrettably, the importance of such proposals is grossly underestimated or just rejected. I was very much surprised when I read an interview (the newspaper *Sovietskaya Rossiya*, January 31, 1988) with Dr. L. Ilyin, a member of the Academy of Medical Sciences, who said literally this: "Any attempts to move nuclear power stations to unpopulated areas would be economically counter-productive." A classical case of incompetence. One has every right to ask this medical gentleman: did he ever consider what the gains and losses of this project would be? Even the simplest calculations show that the construction of a speedway for bringing the personnel of a nuclear power station from home to their place of work over a distance of 30-50 km would amount to a fraction of the building costs of the station itself, let alone the damage caused by an accident.

Utilisation of energy from high and low tides, also from the energy of the sun and the wind, of the internal heat of the Earth, thermal water, and the agricultural waste holds out great prospects for the production of electric power. Actually both the USSR and other countries have made some successful attempts at their practical utilisation. One should keep in mind that not one of these energy sources can boast any specific advantage over the others. With scientific and technical progress, their scale and use are changing all the time. This is why we need a well-substantiated long-term programme for a comprehensive, well-coordinated utilisation of different energy sources that would allow for the specific features of every region of the country. One thing is clear: the programme must give preference to renewable and inexhaustible resources and to ecologically harmless technologies.

All the above energy sources require much time and efforts for their development and practical utilisation.

There is still another radical way to make energy production safer ecologically. This is the more economical utilisation of energy. For the less energy we consume, the less energy we need for its production, and consequently the smaller is its negative effect on the environment. There are great possibilities in this direction. According to the Soviet energy specialist Academician L. Melentiev, "already now the existing energy-saving measures could reduce the production of primary energy resources roughly by half". These are just two examples of the scale of the possible economy of energy.

First. The loss of natural gas in its transportation and storage, also that of casing-head gas in flares comes to 28-30 million tons of equivalent fuel. These losses are equal to the entire electric power generated by all the nuclear power stations of the Soviet Union in 1988. Regrettably, instead of working out new concrete measures to save gas, some scientists (Yu. Bokserman, N. Cherski) propose to increase its production to as much as 1,000 billion cu m a year. This raises the question: what is the real reason for increasing the output of energy from different resources, if we expend two tons of fuel where high technology countries can do with a mere one ton. Let's recall that already in 1987 our country produced 727 billion cu m of natural gas, which is 50 per cent more than its production in the United States.

Second. The switching of steel-making from open-hearth to oxygen would save 27 per cent of energy.

The conservation of energy must be the principal direction of scientific and technical progress in all the sectors of the Soviet national economy.

MINING AND METALLURGY

Primary industries make up the basis of modern industrial production. At present about 400 types of mineral raw materials and fuel (a total of 120 billion tons) are extracted and used for different needs. Approximately every 15-18 years the volume of extraction is doubled. In the Soviet Union this occurs every 8-10 years, which can be explained by the hypertrophied development of the fuel and raw material sector. The share of our country in world extraction of mineral wealth is growing steadily. Today it constitutes 22-23 per cent.

The mining industry of this country employs 18 million workers, and gets 40 per cent of all capital investments. Being the most capital-intensive and resource-intensive, primary industries inflict the worst damage upon the natural environment, and hence upon the economy. According to Soviet economists, capital investment per rouble of growth of production in iron ore extraction is three times as high as in power engineering, in the coal industry is twice as great, and in the production of coking coal — 2.8 times as great. Moreover, capital intensity and other expenses in the fuel and raw material sector tend to increase. For example, from 1981 to 1986 the expenses per one rouble of commercial output in the fuel-and-power sector rose by 8.6 per cent, including 13.2 per cent in the fuel industry. At the same time the expenses per rouble of commodity production in the machine-building industry dropped by 7.5 per cent.

The growing expenses in the primary industries come from the deteriorating conditions of extraction because the richest deposits are getting more and more depleted and the mining operation is thus being moved further east and north. This makes it necessary to explore and open up deposits with lower concentrations of usable material, and carry out the extraction from great depths. For example, the average depth of oil wells in the USSR grew from 1,200 m in 1945 to 2,800-3,000 m in 1985. More and more funds are being expended on geological survey. In 1970 this sum stood at 3.2 billion roubles, whereas in 1988 it had risen to 7.9 billion (in comparable prices). The cost of one metre of shaft sinking in deep exploration drilling for oil and gas was 387 roubles in 1980, and 518 roubles in 1988. This is the economic side of the rapid development of the primary industry. But what are its ecological consequences?

The amount of waste left after the extraction and enrichment of minerals in the USSR runs into billions of tons. Most of it comes from the coal and chemical industries, the iron-and-steel and non-ferrous metal industries, and from the building industry. Mining accounts for 70-75 per cent of the entire industrial waste. According to very rough estimates, more than 3.5 billion tons of waste from mining accumulate throughout the Soviet Union every year. Significantly, a mere 6-7 per cent are utilised.

Most of the solid waste is stored up in large piles which take up vast areas. These disrupt the natural landscape, pollute the air, also surface and underground water. Waste dumps build up primarily near populated centres, which aggravates the situation. According to experts at the Makeyevka Civil Engineering Institute, the waste dumps around the coal mines of Donetsk and Makeyevka take up a territory of more than 900 hectares. The dumps of this industrial area contain more than 230 million cu m of waste rock, with 16 million cu m added every year. Altogether the coal mines in this country extract 1.2 billion cu m of overburden and spoil rock, whereas the coal-enriching factories produce 60 million cu m of spoil. Every year 6.000 hectares of farmland are set aside to accommodate waste material, and that in addition to the 40 thousand hectares already covered with mining waste. More than two billion cu m of underground water heavy with suspended material and salt are pumped out of coal mines and open-cast collieries.

At mining and ore-dressing mills about 1.8 billion tons of waste comes from open-cast and underground extraction of metal ore. Stripping and ore-dressing operations leave behind an annual total of about 1.8 billion tons of rock waste. In addition to that, about 200 million tons of waste comes from the extraction and enrichment of manganese and chromium ores, limestone, dolomite, refractory clays and other non-ore materials. Every year nonferrous metal enterprises bring up to the surface

150-200 million cu m of overburden and enclosing rock; the building materials industry extracts about 400 million cu m of overburden.

Over the past several decades the open-cast method of extraction has become widespread. For example, in 1970 27 per cent of the coal mined in the Soviet Union came through this method, whereas by the year 1988 its share had grown to 44 per cent. It is widely believed that, from the economic point of view, this is the most advantageous method of extraction. There is a point here. The expenses involved in per unit of coal or ore mined are one third, and sometimes even one half as high as they are in the shaft method of extraction. Actually, there is little economy here, if any. It seems economical only when the expenditures and the results are compared within one particular industry. The picture changes sharply if account is taken of the effect that the mining industry has on related sectors of the national economy and on the environment.

Here is a good example. The coal mining industry of the USSR takes up an average of eight hectares of farmland per every million tons of coal mined. The shaft method of coal mining draw away 2-3 hectares of land, whereas the open-cast method 20-30 hectares.[1] A considerable part of the land set aside for the mining of coal and metal ore is fit for agricultural production. Let's assume that one hectare of farmland costs an average of 40,000 roubles, and that such lands constitute half of the area used for mining purposes. This fairly accurate assessment means that with the mining of one million tons of coal by the traditional method our national economy loses 80,000-120,000 roubles, whereas with the open-cast method the losses constitute 800,000-1,200,000 roubles. Every year the USSR mines about 350 million tons of coal by the open-cast method. This means that every year the national economy loses 280-420 million roubles a year through the loss of land alone. This is the price we pay for so-called technical progress in the mining industry.

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[1] M. Lemeshev, "An Ecologo-Economic Evaluation of Scientific and Technical Progress", *Voprosy ekonomiki*, 1987, No. 3, p. 35.

The scale of the damage that the mining industry inflicts upon the national economy is graphically illustrated by the mining of iron ore in the Kursk Magnetic Anomaly, one of the richest deposits of iron ore.

Most of the iron ore extraction here is done by the open-cast method. The deposits of Kursk Magnetic Anomaly (KMA) constitute up to 30 per cent of the national deposits of iron ore and the bulk of rich iron ores. The reserves of rich iron ore are particularly precious since their utilisation dramatically improves the quality of metal smelting, and thus helps obtain the final product at a low cost.

About 60 per cent of rich iron ore lies at the depth of more that 500 m whence it can be obtained only by mining. But where the deposits lie at a comparatively shallow depth and where they can be extracted by open-casting, the rich iron ore constitutes not more than 30 per cent of the total. To extract the rich ore selectively would be impossible. This leads to indiscriminate extraction of iron ore and its enrichment at locally built ore-dressing mills which separate iron concentrate from waste rock.

Meanwhile the fallacious idea of obtaining rich ore by way of what was thought to be the most economical open-cast method was the principal argument in favour of creating giant excavations in the Kursk Magnetic Anomaly. However, these optimistic forecasts were not borne out in practice. More and more funds were expended in the process of ore-dressing. As a result, the cost of production per ton of ore in the KMA is 45 roubles, with more than half this sum spent on ore-dressing.

If we add the other "usual" expenses, i. e. the costs of recultivation of land, water protection measures, and transportation (removal of 5 tons of overburden per ton of ore), all of which are common operations in open-cast ore extraction, the total cost of production of one ton of ore comes to 60 and even 67 roubles per ton. All that is a mere 15 per cent less than the cost of traditional underground mining. The question suggests itself: does not the open-cast method of ore extraction in the KMA lose its erstwhile advantages over underground mining?

There are certain calculations in this respect, and these are not in favour of the open-cast method.

If we extract selectively only rich ores (which is possible only in underground mining), then the need for costly process of ore-dressing almost completely falls away. Then the reduced costs of one ton of iron ore would be 19 roubles, and not 22-36 roubles, as is the case today.

This, however, is not the only advantage. It is necessary to evaluate the effectiveness of one method or another in combination with other factors, considering the interests of the national economy as a whole, and not just one branch. All the more so as the question at issue is not merely the operation of certain mining enterprises, but the formation of a major territorial-production complex (TPC), the economic and social development of the region over many years to come.

The KMA is not only iron ore, but also the famous Russian black earth. To set the record straight the economic value of black earth, if viewed on a national scale, is just as great as the value of the iron ore mined here. We have large reserves of metal ore, but by far not all of its deposits have been discovered whereas the area of black earth — this most important natural asset of the country — is a lot smaller than it was yesterday. The gravity of the situation is highlighted by the fact that these losses are virtually irreplaceable.

Now, how does the open-cast method of ore extraction affect the ploughland?

Mining operations carried out within the TPC's borders have alienated 36,000 hectares of agricultural area (mostly ploughland). But this is only one side of the question. Significantly, the auxiliary and allied operations take up ten times as much area as the extraction of iron ore itself requires.

The ore extraction industry has a deleterious effect on crop harvests in neighbouring regions (dusting, discharge of gas, etc.). It has been established that the total area of such land is five, or even eight times as great as the area directly affected by ore mining. Thus, the area affected by ore extraction within the TPC's borders is no less than 100,000 hectares. The yields of cereal crops on such territory is 30 and even 50 per cent less. Recultivation of the disrupted soil has a very limited effect.

The ore mining authorities do not carry out recultivation properly allegedly because there are no empty quarries, fully formed spoil banks, also because they have no specialised machinery or recultivation plans. And since recultivation costs are charged to the cost of ore produced, the establishments concerned find any such work unprofitable. Suffice it to say that the cost of recultivation of one hectare of land comes to 25,000 roubles. This is why a mere 2 per cent of disrupted soil has so far been returned to agriculture.

And even if recultivation goes far enough, only 10 or 20 per cent of the soil is expected to be properly restored.

Open-cast ore extraction will have an increasingly harmful effect on the farming of the black earth regions of the country with the expansion of the TPC. The area thus affected is about 4 million hectares. Let's not ignore the fact that this is a densely populated area.

In choosing the way the complex of the Kursk Magnetic Anomaly will develop, this circumstance will be given priority. And this circumstance unequivocally argues against open-cast mining in the black earth zones with a dense population and in favour of moving the ore extraction process deep underground.

In open-cast mining the fertile topsoil is removed. At present not less than 100 million tons of black earth have been accumulated in the storage piles of ore-mining enterprises. This has brought forth a special kind of black earth amelioration here when the fertile topsoil thus stripped is moved to the neighbouring fields suffering from erosion.

However, the process of formation of gigantic spoil banks proceeds at a much faster rate than this soil disposal operation. As a result, such storage of black earth in piles leads to the gradual loss of its fertility. Today nobody is responsible for it. This is why the black earth stripped in the process of mining must be utilised bypassing its long storage. It is necessary to include black-earth amelioration in the technological process of open-cast mining.

The worst enemy of black earth in the KMA is erosion which, in the Belgorod Region alone, has affected 54 per cent of the ploughland. The struggle against erosion and gully-forming is one of the most urgent and crucial problems. The idea is to prevent the increasing depletion of the natural fertility of black earth.

And here we can turn to advantage what seems to be so harmful to local farming: the formation of waste dumps around ore-dressing mills. If the overburden is used for filling gullies within the radius of 50 kilometres of every ore-dressing mill (which is quite feasible from both the technical and economic points of view) and is then overlaid by a layer of fertile soil removed in the course of the stripping operation, then not less than 100,000-150,000 hectares of highly productive land can be brought back into farming operation.

The local industrial establishments have the necessary equipment for the job: efficient earth-moving machinery for levelling out and filling up of gullies and depressions, motor vehicles, etc. But there is one thing that they do not have: the personal incentive for the workers. Black earth amelioration should be turned into an independent commercial undertaking run on a profit-and-loss accounting basis so that they could carry out the job on orders from agricultural enterprises at their own expense and with government subsidies.

However, the damage inflicted upon the national economy is not confined to the loss of land alone.

Fresh water is no less valuable than the arable land. But since open-cast mining requires large expenditures of water, much of it goes to waste. Suffice it to say that both the stripping and ore-dressing operations use up 8-10 cubic metres of water per each ton of rock material. Altogether, 700 million cu m of water is expended in the KMA every year. Water managing experts believe that this amount corresponds to the entire TPC water run-off (without reservoirs).

Today the vast region of the KMA suffers from an acute water shortage, which has again raised the question of diverting part of the water from the Oka and Volga rivers.

This, however, is not the limit to the truly destructive effect of mining operations on the water balance of this region. The creation of deep quarries followed by intensive drainage leads to the creation of funnels and to excessive drainage of large land areas, with their declining crop yields. In the KMA 250,000 hectares of agricultural land suffer from inadequate water supply. In all TPC major industrial centres and towns the level of ground water has dropped considerably. In and around Belgorod it has gone down 16 m, in Kursk 60 m, and in the town of Gubkin a whole 100 m.

Another dangerous phenomenon is the rise of mineralised water from deeper to upper strata. This is not only salt water unfit for drinking but also fluorinated water. The emergence of such waters is a local phenomenon, so far. However, the expansion of open-cast mining of iron ore and the development of a far-flung drainage system, with its numerous unwatering holes can cause an extensive seepage of mineralised water.

As is known, deterioration of the quality of water is even more dangerous than declining water intake. The productivity of water intake can be restored within a few years, whereas the quality of underground water cannot be improved even over a long period. Some experts think that the restoration of quality is a technical impossibility. This is why the threat of pollution of clean ground (near the surface) waters in the KMA with heavily mineralised water in deep horizons merits special attention. It is very hard to prophesy the consequences of such pollution. One thing is clear: it is necessary to curb any further development of this process at all costs.

Actually, there is an alternative to this. The way-out should be sought in the development of underground mining. This will solve the problem of conservation and rational utilisation of irreplaceable natural resources.

The development of the KMA in this direction clearly shows promise, as confirmed by researchers. If we sum up all production costs, nature conservation expenses, the damage inflicted upon our farming and water handling facilities by open-cast and underground mining (reckoned for one million tons of iron ore), and compare the total expenditures with the returns (at wholesale prices) the picture will be as follows: extraction of one million tons of ore by open-cast mining inflicts a loss of 20 million roubles. But in underground iron-ore extraction the economic effect would be 10 million roubles.

And yet the sectoral concepts of a territorial-and-production complex rests on the conservation and indeed expansion of open-cast mining. And this is where most of the funds are invested whereas the only major ore mine for underground exploitation in the KMA, called the Yakovlevo Mine, has been under construction for twenty years.

This is obviously the result of narrow departmentalism and concern only for departmental interests largely at the expense of the interests of the nation as a whole. The steadily growing extraction of iron ore is prompted by purely sectoral interests, by a desire to increase the volume of iron ore mined in the country.

A similar situation obtains at the sites of other mineral deposits. Special mention should be made of the extensive excavation of apatites in the Kola Peninsula under the authority of the Ministry for Mineral Fertilisers. All that this ministry is concerned about is the production of phosphate fertilisers, whereas the other valuable components, which add up to hundreds of millions of tons, go to waste, including about 40 per cent of nephelines, an important element in the production of cement, alumina, and soda. The demand for these products remains unsatisfied from internal sources, and we are compelled to import them from abroad.

Both the Soviet Union and other countries have efficient technological methods of utilising such waste material, and are equipped sufficiently well to process the materials which would otherwise go to waste. For example, the Yuzhkuzbassugol production association in

Kemerovo region produces high-quality bricks out of tailings which go into brick-making by semi-dry pressing. Although the brick factory does not have any special quarries, excavators, or lorries, it produces 30,000 excellent bricks a day. The advantages derived from this operation are two-fold. First, the territory around the ore-dressing mill is kept clear of waste materials. Secondly, there is no need for digging quarries for extracting raw materials, which reduces landscape destruction and also the cost of brick production itself. There is another such brick-making factory, the Saburkhanskaya coal concentration mill at the Karaganda-Ugolstroi Amalgamation in Kazakhstan. This factory produces 50 million bricks annually, and reprocesses 150,000 tons of waste material. Significantly, the bricks produced from tailings are much stronger and are, besides, 10-15 per cent lighter than standard. Besides they are 5 or even 6 times more frost-resistant. And production costs are also much lower.

Regrettably, this method has not yet gained wide currency. There are hundreds of brick factories using old technology in this country. Most of these factories are housed in dilapidated buildings and have obsolescent equipment. They need fundamental modernisation. There is no reason why we should not start the production of bricks from tailings after such modernisation, considering the fact that every ore and coal concentration mill can supply cheap raw material for several brick factories.

However, things are moving very slowly because of the lack of coordination between government departments. Dressing enterprises are under the Coal Ministry, which supplies them with financial and material resources. Such factories are naturally concerned with their production targets and are busy with producing as much coal as possible. Brick factories operate under the Ministry for Building Materials which finances them and which thus orients them towards meeting targets in brick production. This disunity of interests and goals is damaging not only to the natural environment, but also to the national economy. Coal-mining areas are literally filled with spoil banks, some of them as high as 50 m and even 100 m. Many spoil banks are affected by spontaneous combustion, raising clouds of smoke and dust which spread over populated centres.

Coal burning for power production leaves lots of waste which can also be put to good use. The high temperature developed in coal burning furnaces causes part of the iron to reduce, forming tiny spheroidal beads on its surface. These contain more than 70 per cent of iron which, besides, is alloyed with manganese, vanadium, nickel, titanium. This, in effect, is a concentrate fit for direct reduction of iron and for obtaining metal powders. At each thermal power station the piles of ash contain many thousands of tons of such concentrates.

The consumption of aluminium has risen sharply, and more and more of it will most likely be obtained by pyrometallurgical and hydrometallurgical processes. This is why ash containing 20-35 per cent of alumina is of great practical interest.

This ash also contains large amounts of quicklime which is so important for agriculture. The USSR has more than 60 million hectares of acid soils, especially in the non-black earth regions of the central part of the country, in Siberia and Byelorussia. Such soil contains very little humus, phosphorus, and potassium. In accordance with the rules of agrochemistry, such acid soils must be limed once every four years. For this purpose some 5 or 6 tons of lime must be spread over every hectare of land. However, not enough attention is being paid to this very important agrochemical operation. For example, tens of millions of hectares of acid soil need liming in the RSFSR. Over the past several years not even one third of this area has been treated this way.

Of particular value is the ash from combustible Baltic shale rich in oxides of calcium, manganese, potassium, phosphorus, which form a complex lime fertiliser. It also contains the much needed trace-elements such as boron, manganese, copper and cobalt. The introduction of these fertilisers raises the crop yield of cereals in Estonia alone to 26 centners, and that of potatoes to 205 centners per hectare. In areas of the Russian Federation that are situated north of Estonia, the crop yield of cereals is 11.5 centners and that of potatoes 122 centners, whereas in neighbouring Latvia yields of these crops are correspondingly 14.6 and 134 centners. The experience of Estonia and Central Russia shows that the crop accretion from shale ash is higher than that from the traditional lime meal. The lime ash can also go into the production of calcium cyanamide, which is a valuable nitric fertiliser for acid soils.

The large-scale construction of thermal power stations run on coal in the Kansk-Achinsk basin in Siberia has created great possibilities for the effective utilisation of ash in the agriculture of this region.

As we said earlier on, metallurgy is a major source of environmental pollution. Ferrous metallurgy alone produces 20 million tons of slag annually. However, only one quarter of this amount is put to good use, in spite of the fact that slag is a valuable secondary raw material. The slag obtained from blast furnaces goes into the production of more than 30 million tons of portland blastfurnace slag cement. It is also used in the building of motorways. After they have been ground up and undergone magnetic separation, slags that are high in phosphorus can be used as an excellent fertiliser which is just as efficient as superphosphate. The experience of utilisation of, for example, Karaganda phosphate slag shows that when admixed to the soil it can raise the crop yield of vegetables and potatoes more than 50 per cent.

Every year the non-ferrous metal industry leaves behind about 20 million tons of slag out of which not more than 20 per cent is utilised. This slag is noted for the presence in it of non-ferrous, rare and even noble metals, making it inexpedient for use as a building material. The complex treatment of the slag is done in three stages: extraction of non-ferrous and rare metals, separation of iron from it, utilisation of the silicate remainder as a building material only. Useful in this respect is the rich experience of the socialist countries, notably Hungary (utilisation of the red silt in aluminium production) and the German Democratic Republic (utilisation of the waste left from processing of lead, zinc and polymetallic ores).

A serious problem arises from air pollution by metal smelting plants. Iron and steel production holds second place (after power industry) for the amount of pollutants discharged into the atmosphere. In 1987, this discharge was 10.9 million tons, including 7.0 million tons of carbon dioxide, 2.2 million tons of solid matter, 1.1 million tons of sulphur dioxide, 0.4 million tons of nitric oxides. Next after the iron-and-steel industry comes non-ferrous metallurgy whose total discharge into the atmosphere is 6.2 million tons, including 4.6 million tons of sulphur dioxide, 0.8 million tons of dust, 0.6 million tons of carbon dioxide. The dust coming from metallurgical operations is highly toxic (especially in non-ferrous metallurgy), because it contains heavy metal compounds and benzopyrine. The main health hazard of these operations comes from their close proximity to large cities, particularly when they are in direct proximity to blocks of houses. As a result, cities like Kemerovo, Kommunarsk, Nizhni Tagil, Lipetsk, Sverdlovsk, Magnitogorsk, Zaporozhie, Mednogorsk, Bratsk, Berezniki, Balkhash, Karabash, Revda and some others have a higher sickness rate than elsewhere in the Soviet Union.

Most of the Soviet metallurgical plants need modernisation with a consideration given to modern ecological requirements. The experience of the leading industrial countries shows that metallic discharge can be coped with. This applies particularly to the trapping of dust in off-gas (a valuable raw material thanks to the high content of metal in it) and sulphur dioxide (especially in the non-ferrous metal smelting industry). Meanwhile the metallurgical plants of the Soviet Union make their "contribution" (5.8 million tons of sulphur dioxide) to the notorious acid rains.

The negative effect of the steel industry on the natural environment can be eased by reducing metal intensity. Although the Soviet Union produces tremendous amounts of cast iron and steel, their chronic shortage still plagues our national economy. There are at least three factors behind it. First, much of the metal is lost in smelting and processing; second, the low quality of metal, which increases per unit metal expenditure in goods manufacturing, its susceptibility to corrosion; third, machinery and equipment are often produced in unreasonable quantities and in excess of actual demand.

The first two causes can, strangely enough, be removed through using the old way of producing pure iron directly from the ore concentrate bypassing the cast-iron bloomery process, also by widely using powder metallurgy. Our own experience, notably at the Tulachermet research and production association, clearly shows that this method makes it possible to produce articles of the most complicated shapes with the minimum loss of metal and labour. Thus for every thousand tons of manufactured goods from metal powder the industry saves 2,500 tons of steel and 1.5 million roubles, with the number of machine-tool operators thus released coming to about 200.

It should be stressed that metal powder metallurgy is almost completely waste-free. It can produce the most varied composites, some of them so refractory that they can stand up to outer space and thermo-nuclear temperature pressures. Some composites are as light as aluminium, strong as titanium and as resilient as damask steel; porous composites that can be used as the finest of filtres; also muffling composites that dampen vibration and choke sound. There are also so-called "fatty" composites that can be used without lubricants at friction points. Of special merit are fibrous composites enforced with different fibers which make metals strong and lend them many other properties. A thin film made of powder mixtures of plasmic dusting protects metal parts against corrosion and premature wear-and-tear.

Powder metallurgy can revolutionise the technology of metal working, as well as its very production. Work is underway to create a production complex without blast furnaces, open-hearth furnaces, rolling mills, or metal-cutting machine tools. A press filled with powder can produce a mold of any shape which will have not only minimal allowances but also the assigned physical and mechanical properties. All the waste material will be ground down to powder and channelled back into the production process. One such complex is functioning successfully in Zaporozhie (in the Ukraine). Continuous casting, which was developed in the USSR about a quarter of a century ago, is an important source of metal saving. The effectiveness of this method consists in that one ton of molten steel can produce 150 kg more rolled products and of higher quality at that, than in ingot-moulding. This raises labour productivity, reduces capital outlays and the expenditure of power, also makes the entire production process more highly standardised. Many foreign firms have bought Soviet licenses for this new method, and over the past several years most countries have been making wider use of it as a highly economical process. In 1988 the proportion of continuous casting in total steel production constituted 59 per cent in the United States, 88 per cent in West Germany, 93 per cent in Japan, 93 per cent in France and 16 per cent in the Soviet Union.[1]

Our metallurgy is not in a hurry to take advantage of this unique Soviet achievement of scientific and technological progress, but continues to build mammoth furnaces which are obsolescent from both the technological and ecological points of view. In the Seventh Five-Year Plan period the maximum capacity of these giants was 2,300 cu m whereas in 1986 the giant blast furnace called Severianka in Cherepovets holds over 5,000 cu m. Meanwhile the transition to a new method of steel production ensures the saving of resources, higher national economic efficiency and conservation of the environment. As was pointed out above, the Soviet Union produces 162 million tons of steel annually. Continuous casting makes it possible to obtain the same amount of rolled products, expending 15 per cent less metal than by ingot-moulding. In other words, we can safely reduce the amount of steel smelting by 24 million tons a year. This in turn would also make it possible to reduce iron ore extraction by 48-50 million tons. Such is the economic and ecological effect that could be achieved by using just one new method.

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[1] M. Lemeshev, "An Ecologo-Economic Evaluation of Scientific and Technological Progress", *Voprosi ekonomiki*, 1987, No. 3, p. 36.

Speaking about the economy of natural resources, one should also remember that mineral raw material is irreplaceable, and that its reserves are not unlimited. The ore once mined is not to be replaced. In many places the "underground store of wealth" is getting more and more depleted, making the excavation process increasingly more difficult. For instance, 15 years ago the extraction of raw material worth one rouble required two roubles of capital investment, whereas today this sum has grown to four roubles. At the same time iron ore mining now costs three times as much. This is why it is so crucial to create a waste-free technology and to draw into production the entire raw material which has been taken from the natural environment and into which we have invested so much work.

With the rich mineral deposits getting thinner, the miners have more and more often to work poor deposits. To build ore mines in such cases is a very costly proposition. This is why the most promising method is to use the underground geochemical method of production because it can dispense with mines, quarries and spoil banks. Actually this method is widely used in sulphur production in the Soviet Union. The making of sulphur underground is one quarter, and even one fifth as costly as its production by traditional and open-cast mining for the same amount of sulphur obtained. In the United States geochemical methods are used in copper mining. Technologies have been worked out for the underground leaching of iron, phosphorus, and some other minerals.

However, these methods are in rather limited use. To this day large areas of rich land are scarred and are left disintegrating, eaten up by spoil banks. This makes soil recultivation a priority problem.

To reduce the metal intensity of social production and, consequently, to reduce ore mining, to slow down the destruction of land, the pollution of water and air would be possible if the metal produced were of better quality. Soviet industry has a perennial metal shortage, or rather a shortage of metal that is strong, light, and corrosion-resistant. This problem can at least in part be solved by producing metal with a corrosion-resistant coating. In the United States and Japan, half the rolled products are protected in this way. In the United States eighty continuous strip galvanising lines were in operation back in the 1970s whereas in the Soviet Union only four such lines for producing zinc-coated steel strip were in operation in 1988. Today we need 250,000-300,000 tons of zinc-coated steel strip, whereas only 8,000 tons are actually produced. Besides, the production of metal with anti-corrosion coating reduces the industrial consumption of metal in the manufacturing and building industries by 20-25 per cent.

The Soviet Union has developed an effective technology for the production of super-strong zinc-coated strips. However, owing to the lack of incentive for its application by the manufacturers, this technology is not much in use because it reduces the volume of output on the basis of which payment is made.

CHEMICAL INDUSTRY

Industrial facilities operating under the ministries of the petrochemical industry and fertiliser production are so numerous that they have formed an extensive network covering practically the entire territory of the Soviet Union. Moreover, these facilities are largely concentrated in big cities or in suburban zones with a dense population, and almost always on the banks of rivers, lakes and storage reservoirs. The very existence of these enterprises is a source of ecological danger for vast territories and also large population groups. The chemical effluent pollutes practically all components of the natural environment—air, water soil, also food and household goods. The adverse effect that the chemical industry in the USSR has on the natural environment is largely the result of the fact that it is advancing at a much faster rate than other industries.

Table 7

Production Growth Rates in Different Industries (USSR)

	1970	1980	1987
Industry as a whole	100	178	224
electrical power industry	100	180	221
light industry	100	148	162
food industry	100	140	174
chemical industry as a whole	100	225	317
basic chemistry	100	232	332
chemical and farmaceutical production	100	381	411
artificial fertilisers	100	191	276
pesticides	100	238	332

The growing chemical production is putting increasing pressure on the environment and human health. The combined atmospheric discharge of the mentioned industrial facilities is 5.7 million tons of pollutants (in 1987). Significantly, most of this discharge comes from the oil refining and petrochemical industries which are notorious for tremendous losses of hydrocarbon material at all the stages of processing, transportation and storage. The atmospheric discharge from chemical plants and from fertiliser factories are not as massive (930,000 and 720,000 tons respectively), but it is a lot more toxic and therefore more dangerous for man. There is a recurring pattern about the production of chemicals: the more complex their processing, the more toxic they are. This explains why oil refining establishments discharge into the air mostly saturated hydrocarbons and bensonic substances, whereas chemical plants throw out into the air a wide spectrum of highly toxic substances. In practically all cities with fibre-making plants the air contains high concentrations of pollutants such as carbon bisulphide (Kalinin, Mogilev, Balakovo, Kiev, Klin, Barnaul), ammonia (Kirovakan, Berezniki, Cherkassy) and formaldehyde (Novocherkassk, Usolie-Sibirskoye). The plants that manufacture synthetic organic substances and chemical reagents throw out into the air phenols, chlorides, hydrochloride, acetone, ethyl acetate, methylmercaptan, benzopyrine, and many other toxic substances.

Fertiliser plants also create problems. In addition to carbon dioxide, nitrogen oxides and sulphur dioxides, which are not so toxic, they also discharge hydrogen sulphide, carbon bisulphide, hydrogen fluoride, hydrogen chloride, sulphuric acid, dimethylamine, cyclohexanol, hydrogen cyanide into the air of our cities and towns. Such plants operating in Kemerovo, Sumgait, Djambul, Voskresensk, Monchegorsk, Rovno, Cherkassy, Berezniki have created a particularly grim ecological situation there.

Among the catalysts used in different chemical operations are heavy metals, such as mercury and lead. Even small concentrations of these metals induce pathological effects in people, let alone the production of pesticides (notably fungicides) which always contain mercury.

The oil refinery in Ufa provides a good example of the tremendous harm that the oil refining industry inflicts upon the natural environment and human health. Much of Ufa (pop. one million) is directly affected by the operation of this plant. The worst affected is the Ordjonikidze district of the city. To assess the degree of pollution in a given area hygienists have introduced a reference unit: the maximum permissible concentration (MPC) of a given substance present in the environment. In other words, this is a concentration above which even the seemingly impressive achievements of technical progress become a source of illness for humans.

According to available statistics, the concentration of chemicals in excess of the MPC in the Ordjonikidze district of Ufa is 8.3 times for chlorine, almost 3 times for chlorphenol and benzopyrine, 1.6 times for hydrogen chloride. These are average figures, because on days when massive or emergency ejections occur, the degree of contamination of the atmosphere is much higher. For example, in May, 1985, the concentration of benzopyrine in the atmosphere here was tens of times above the MPC.

All that cannot but have an adverse effect on the health of local residents. In the Ordjonikidze district the morbidity rate is 50 per cent higher than, for example, in the Leningrad district of Ufa (which can hardly be regarded as an ecological paradise). The incidence of disease among children is 2.5 times higher here than elsewhere in the city.

Over the past eight years about 75 million roubles has been spent in Ufa on environmental protection. Any results? The air in Ufa has become even worse than before, because over this period some of the local plants launched the production of aromatic hydrocarbons, highest fatty alcohols, diphenylpropane, some toxic chemicals. They also have increased the output of phenol and acetone. The technology used in the production of these chemicals is impermissible from the point of view of nature conservation.

Thus Ufa is gradually becoming a place unfit for human habitation, and no arguments can justify this situation. What is more, the future bodes nothing good from the environmental point of view. The construction of facilities which was recently started for the production of artificial fibres and polycarbonates at the Khimprom association, it is feared, will aggravate environmental pollution still further.

No less harmful is the effect that the chemical industry has on water resources, the Volga being a case in point. On the map the great Russian river looks like a necklace, with numerous chemical and petrochemical plants tacked onto its blue thread. These industrial establishments operate in Kalinin, Yaroslavl, Dzerzhinsk, Kazan, Balakovo, Kuibyshev, Novokuibyshevsk, Togliatti, Saratov, Volgograd, Volzhski, and Astrakhan. Together with the high dams that have blocked the river like emboli blocking blood vessels, these chemical plants have created a critical situation for the fisheries of this truly unique region of our country.

In the summer of 1988 hundreds of thousands of sturgeon died in the Volga over the space of just one week. That loss was assessed at 35 million roubles. This, however, is by far not the only damage caused by the combined efforts of high-dam builders and the managers of the chemical industry. At risk is the procreation of a whole biological species: the Russian sturgeon. In both Volgograd and Astrakhan special commissions have been set up to investigate the causes of the disaster. Attempts are being made to find those responsible and to find the exact spot where the fateful massive ejection of chemicals occurred. This can clearly be interpreted as an attempt to camouflage the real reasons for the ecological malaise of the Volga basin, such as the disruption of the hydrological regime of the Volga, the slow water exchange in the river (five and even seven times below its natural flow intensity) and its dangerous pollution, primarily with chemical effluent.

The chemical industry makes its "contribution" to the contamination of the Volga and other rivers and lakes not only directly by throwing toxic chemicals into the water, but also indirectly by chemicalisation of agriculture. Utilisation of artificial fertilisers and toxic chemicals in farm production is growing rapidly. Most of the chemicals disseminated in the fields, especially irrigated areas, gets into the water, including the underground water which is used for drinking and household needs. The worst contamination comes from toxic chemicals, particularly pesticides, whose production is growing rapidly. Suffice it to say that our chemical industry raised the output of fertilisers 2.8 times in the period from 1970 to 1986, whereas the production of herbicides grew 3.3 times. The situation is aggravated by the fact that chemicals are frittered away, that much of them are lost in transit, in careless storage, also through the use of inadequate technologies whereby they are introduced into the soil and used for treating farm crops. Also ill-thought-out is the geography of the chemical industry and that of the application of toxic chemicals. For example, the Crimea is a unique nature zone of world importance. The celebrated Chilean poet Pablo Neruda said, after visiting the Crimea that "it is a medal on the chest of the planet Earth". This region is blessed not only for its sunshine, not only for the beauty of its sea and mountains, its varied flora and fauna, but also for the healthful resources of mineral water and curative muds. As a health resort the Crimea has no peer in this country. No wonder it has the status of national health resort. Every year more and more holiday-makers come to the Crimea from other countries, as well as from all over the Soviet Union. In 1958 the number of visitors was 300,000, in 1968 their number had grown to 4 million, and in 1988 to 9 million. But at the same time a number of industrial enterprises were set up here for the production of aniline dyes, bromides and soda, and titanium dioxide. The total amount of harmful effluent dumped into the acid collector by the Titan association and by the Sivash aniline dye factory is 20 million cu m a year. Originally this collector was designed for the amount of effluent that could fill it up over 25 years. However, because of expanding the growing production the collector was filled up over a mere six years. After that the effluent spilled over and began to rapidly spread outside it, polluting everything around it, and worst of all, scarce fresh water reserves. A total of 750 hectares of precious land has been completely or largely flooded. The maximum permissible levels of concentration for sulphuric compounds have been exceeded 10 times over, for ammonia 9.7 times over, for fluorides 6.1 times. These pollutants began to penetrate into the first, and later into the second horizon of underground water. This is particularly dangerous because 70 per cent of all drinking water in the Crimea is in its underground reserves. Today the drinking water contains high concentrations of iron and arsenic, which has put the entire drinking water supply at risk. Chemical pollution affects the air of the Crimea's recreation zone as well. Recently Minkhimprom (Chemical Ministry of the USSR) passed a decision on the construction of a joint Soviet-Swiss industrial enterprise, called Tavria, for the production of sulphur dyes. The technology of its production has been developed and offered by the ill-famed Sandoz company.

The leaders of Minkhimprom are, as always, full of ecological optimism and are determined to transmit this optimism to the public. This is how the situation in the Crimea was described by one of the ministerial executives in connection with the construction of a major chemical facility there. "The advanced technology at the disposal of the Sandoz company, also the equipment and the means of automation and mechanisation which this company has undertaken to supply us with, make it possible to create an ecologically harmless production (there will be practically no discharge into the atmosphere, the effluent will be made perfectly clean at purifying installations built for the plant as a whole and also at smaller local installations). This is why the said production operations pose no danger for the ecology of the Northern Crimea."

A paean of praise for a Swiss chemical concern! The impression is that an executive at Minkhimprom of the USSR learned about the activities of the firm only from brightly coloured posters before making up his mind. What a ridiculous reason for making a decision as vital as that. This is all the more astounding because Sandoz has a poor safety and ecological record. In the autumn of 1986, for example, the storehouse of this concern in Basel caught fire. Luckily, the fire which had rapidly spread towards the crates of potassium and phosgene was soon brought under control. The worst was averted. However, together with the water that extinguished the blaze, many tons of toxic chemicals were flushed into the Rhine. As a result, a poisonous slick, some 70 km long spread downstream. This caused serious interruptions in the water supply of many cities and towns on the Rhine. The chemicals killed hundreds of thousands of trout and eels. At the end of 1987 a powerful explosion rocked the Sandoz facilities in Basel, injuring six workers. In 1988, a major accident occurred at a Sandoz plant in West Germany. A pink mist hung over the Rhine for several days. The company paid two million dollars in damages. That, however, was not the end of the incident: the West German authorities demanded that the Sandoz take its facilities out of the country.

These "exploits" of the Sandoz company did not bother the officials of Minkhimprom. There is still another important aspect of the activities of the chemical industry. Chemical production is highly energy-intensive. Therefore their concentration in one area requires the construction of large power generators somewhere nearby, which will inevitably aggravate the ecological situation still further. The anthropogenic pressure on the natural environment is growing. The rapid expansion of chemical production in the Crimea has brought forth plans for the construction of a nuclear power station which is out of place here both as regards socio-economic tasks confronting this region and as regards the seismic and engineering-geological features of the territory.

The overall unfavourable ecological situation in the Crimea induced by the spread of the chemical industry is being aggravated by the intensive utilisation of toxic chemicals in agriculture. Every year more than 30 kg of per capita amount of toxic chemicals are used for the treatment of rice fields, vegetables, orchards and vineyards. And if clean products are necessary for all people, they must be needed all the more so by people who come to the Crimea in order to improve their health. I must add here that the effect of chemical protection of plants from pests is rather low and is getting lower as time goes by. Some ten years ago it took a mere 1.5-2.0 kg of chlorophos per hectare to control the Colorado beetle, whereas now it takes six times this amount to achieve the same result.

This and similar ecological effects call for limiting the production of chemicals, for carefully planning the distribution of chemical operations, and for improving technological processes strictly in accordance with ecological requirements.

The heart of all industrial production is machine-building. Over at least past two centuries man linked with the machine all his hopes for conquering nature and for making his life happier. His hopes might come true but for a remarkable paradox. On the one hand, man regards himself as all-powerful, and on the other he does not rely on his strength and seeks to redouble it with the help of the machine and in this way to enhance the productivity of his labour. Marx pointed out that machinery is the most powerful means for increasing the productiveness of labour.[1]

This may well be so. If we take a cursory look at the practice of our machine-building we may think that there is no reason for worry.

We devoted special attention to the development of this branch of heavy industry, and gave it priority over all the other branches. From 1970 to 1988 the total volume of industrial output in the USSR rose 2.2 times, whereas the volume of machine-building grew 3.7 times. Still more rapid machine-building growth rates have been programmed for the current twelfth five-year period. By the year 1990 industrial output as a whole will have grown by 21-24 per cent, with output in the machine-building industry by 40-45 per cent. As you see, the machine-building industry must develop almost twice as fast as the industrial sector as a whole.

Can this priority growth of machine-building be justified from the economic, social and ecological points of view? This is by far not a rhetorical question. If the role of the machine-building industry is regarded from the old, traditional point of view, the answer is surely expected to be positive. Actually, most of us, and not only political economists and planners, know that machines are about the only means of retooling in all the sectors of the national economy, the only means of mechanisation that eases labour, increases its productivity, makes work more attractive and more prestigious.

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[1] Karl Marx, *Capital*, Vol. I, p. 380.

To achieve these goals the machine-builders not only increase the output of machinery and equipment, but also improve them and increase their capacity. New machines are more costly than those they replace, and the user (i. e. society) has to pay more for them. On the face of it, the idea of technical progress is here. But does machinisation of production always yield the benefits we expect from it? Unfortunately not always by far. This can be judged from the following data that show the dynamics of design, manufacture and commercial utilisation of new technology, also its effectiveness in industry.

Table 8

New Machinery in the USSR (thou.)

	1971-1975	1976-1980	1981-1985	1988
Creation of new models of machinery and equipment	20.0	18.5	17.4	8.0
First developed in the USSR and put into mass production	13.3	13.7	15.7	12.5

As you can see, 62.000 new types and models of machinery were created over 17 years between 1971 and 1988. They were not merely invented by designers and engineers, but were also adopted for practical utilisation in the national economy. Altogether 50,000 different types of such industrial goods were put on production lines. We would like to add here that in 1987 alone 10,000 mass-produced new industrial models were awarded the state seal of quality. One could think that the national economy would reap important economic, social and ecological benefits from the use of these machines and equipment. However, even to this day, we cannot say it has. Let us, for example, look at the dynamics of labour productivity. In the ninth five-year plan period (1971-1975) the average annual rate of productivity growth was 4.5 per cent, in the tenth five-year period (1976-1980) this growth was recorded at 3.3 per cent, in the eleventh five-year plan period 3.1 per cent, and in 1987 the average annual growth was registered at 2.4 per cent. The capital intensity of social production continued to grow, and so did the cost of production. This is the economic effect of the efforts to modernise machinery and make wider use of it.

The contribution made by such mechanisation to the solution of social problems is also very modest. This period was marked by a decline in housing construction. For example, over the ninth five-year plan period 11.2 million apartments were built, in the tenth five-year plan period 10.2 million, and in the eleventh five-year plan period their number dropped to 10.0 million. And that at the time when the population was growing, which made the per capita effect of this decline even more dramatic. Nor did the number of hospitals, outpatient clinics and other medical establishments increase over that period. Actually, their total number in the country had decreased following the amalgamation of public health service establishments. Still more surprising is the fact that in spite of the rapid increase in machine building, very little has been done to raise the level of mechanised labour, to eliminate physically hard and ineffective manual operations. To this day, just as fifteen years ago, over 30 per cent of industrial workers, 50 per cent of builders and about 70 per cent of farmers are engaged in manual labour.

The expanding machine-building industry, far from improving the ecological situation, has brought it to a critical point. All that stems from the fact that new technology is not properly monitored by ecologists. As a result, a new machine is regarded as progressive and economically effective if its power unit and its potential production capacity are higher and labour input is lower.

Here are several examples. *First*. Before the war, earth-digging technology in our country was largely represented by the ordinary shovel. This can be judged from documentaries that recorded the heroic labour of Soviet people building the Magnitka iron-and-steel production complex in the southern Urals. The height of technology in the 1930s was an excavator with a bucket of 0.5 cu m which could in one working shift move 100 cu m of earth and loose rock. This machine could do the work of 30 and even 40 labourers. In the 1960s our industry manufactured 16 cu m walking excavators. The engineers thought it insufficient, and today open-cast colliery called Bogatyr (in Ekibastuz) is worked with rotory excavators that can move 5.500 cu m of overburden or coal in just one hour working shift. This example illustrates the speed at which our very earthly (let alone space) technology is moving. It would be useless trying to count the number of earth diggers that this supergiant could replace.

The technological mammoth can, undoubtedly, help man to win over nature in some cases. However, he must always keep in mind that his achievements may one day turn out to be phyrric victories which they often are. For such an excavator can alone dig up a whole landscape, can destroy the top soil, disrupt its hydrological regime over a vast territory, and turn it into a lifeless desert. This is no fantasy, but a tragic reality. The lunar landcapes of Ekibastuz, of the Kursk Magnetic Anomaly, or Kansk-Achinsk are a good example of such depredation.

Second. In the 1960s our agriculture used mainly the DT-54 caterpillar tractor (power capacity — 54 hp; weight — 3.5 tons). This, in the words of farmers, was a hardworking, tireless "ploughman". Because of its rather light weight and of its caterpillar drive, the tractor neither destroyed or impacted the top soil, did not disrupt its structure, its moisture and air regime in the ploughing horizon. In other words the tractor did not damage soil fertility. Spurred on by the praiseworthy idea of increasing the efficiency of this machine, also the idea of cutting down the number of tractor-drivers, whose shortage has always been an abiding factor in Soviet agriculture, the designers developed, and our industry launched the production of a wheeled tractor, the Kirovets K-700, of 200 hp, and weighing 10 tons. For all its impressive exterior and the praise that economic executives lavished on it, this machine has proved to be highly ineffective both ecologically and economically, because of its weight, its excessive power and wasteful fuel expenditure. This giant costs eight times as much as the basic model (*DT-54*) whereas its efficiency is a mere 2.8 times as great. There is nothing accidental about the fact that the Soviet state is compelled to give collective and state farms thousands of millions of roubles in the form of subsidies for purchasing machinery and for covering production outlays.

This tractor is also ineffective in the sense that it does not carry or pull the mechanisms that would make full use of its potential working capacity.

All these shortcomings are characteristic of other so-called power-saturated tractors. As a result, out of the 258 million horse powers, the combined power capacity of all tractors used in agriculture, only 50 per cent is actually in operation. Nevertheless, work is nearing completion on the manufacture of a new and still more powerful tractor K-701 M. With its 330 hp engine this wheeled tractor will weigh 12 tons. It is more advanced from the purely technical point of view, and its productivity will be 15 per cent higher than the previous model, whereas its per unit fuel expenditure will be reduced by 12 per cent. As a result the economic effect of each such tractor used over one year is expected to be 1,300 roubles. As you see, this tractor is clearly an important step forward as far as a traditional approach to scientific and technical progress is concerned. However, alongside the gains there are also some negative ecological and economic consequences of its exploitation which are just as bad, if not worse.

Third example is associated with power industry. It is widely believed that an increase in unit power is a major technological achievement. Power engineering industry executives make wide use of the unit power indicator because this method of assessment produces impressive figures.

Information based on this method and released by Goskomstat (State Committee for Statistics) is apparently meant to show that our power engineers are really worth their salt.

Table 9

Maximum Installed Capacity of Power-Generating Plant

	1961-1965	1966-1975	1976-1985
Steam turbines (thou. kwh)	300	800	1.200
Hydroturbines (thou. kwh)	225	500	640
Primary oil refining installations (million tons a year)	3	6	8

The above shows that the acceleration of scientific and technical progress extends in full measure to the power industry, too. But how far does it go in such areas as the economy, social relations and ecology? Actually the achievements in these spheres are not encouraging, to say the least. Oddly enough our engineers think that reduction in the expenditure for the unit electric power produced is the only way to increase the net capacity of power-generating machines, including steam turbines. Let's see what has been done to solve this important problem.

The expenditure of equivalent fuel per kwh of electric power was reduced from 367 gr in 1970 to 325 gr in 1988, i.e. by 11 per cent. The rate of growth of labour productivity in power engineering was about half as great as the rate of growth of the output. This means that half its growth was achieved by the attraction of additional labour force. At the same time the negative consequences of the growing unit capacity of steam turbines, especially with regard to the natural environment, are not properly accounted for.

Paradoxically, pressure on the environment is growing in spite of technological progress. For example, a power generator with a steam turbine of 1,200,000 kw must be fitted with a gas-diversion stack as high as 420 m. A smoke-stack of such height at thermal power stations run on coal and oil fuel (even taller smoke-stacks — over 500 m high — will soon be used at the super-giant thermal power stations in the area of the Kansk-Achinsk fuel and energy complex) can spread the dangerous pollutants, such as sulphur dioxide, nitric oxides, over an area with a radius of 1,500 km. Upon entering into a chemical reaction with water vapours and other atmospheric components, these ejects form acid rains which damage agricultural crops, forests, fisheries, animal life, soil fertility and human health over vast territories. The scale of loss to the national economy can be judged from foreign experience. According to Canadian experts, most of the acid rains that fall over Canada come from the territory of the United States, thus inflicting five billion dollar worth of damage upon Canada's national economy every year. By the end of this century the damage from acid rains in Canada is expected to have grown to 15 billion dollars.

The growing unit capacity of power generators yields but an infinitesimal gain above the economic damage inflicted upon the national economy by the pollution from the exploitation of this new technology. In sizing up the optimal capacity of power plants one should also take account of possible losses in the event of accidents which we cannot rule out. When a particularly large power plant goes out of action such losses take the form of a chain reaction.

The corollary of the above is not that we should go back to the use of small-type technology and stop increasing the unit power of our machines. The point at issue is that the growing unit power of technical facilities cannot serve as the principal hallmark of acceleration of scientific and technical progress. This indicator must at least be supplemented with many more technological, economic, social and ecological indicators. This view of the achievements of scientific and technical progress suggests the need for strict comprehensive ecological and economic control over new technology, the kind of control that will be extended not only to the newly designed machines, but also to technological ideas, hypotheses, technical projects and the newly launched facilities.

In the power industry, for example, it is necessary to combine the construction of large, medium-sized and small power generating units. The relatively small thermo- and hydroelectric power stations are particularly expedient, both technologically and economically, for supplying power and heat to small populated centres, livestock farms, field-camps, geological parties, etc. The supply of heat and electric power for such sites from power grids and heating plants is not only very costly, but also technically unsound. Any accident that might lead to a suspension in the operation of a large station or a hydroelectric station, to the destruction of a high-voltage line, paralyses many production activities and disrupts normal life.

The building of relatively small power generators has proved more effective in some countries, notably in Northern Europe. For example, in Finland, Norway and Sweden many small hydropower stations were built on small rivers in the 1970s and 1980s. The construction of highly efficient stationary and mobile diesel power stations operating on natural gas has gained currency in the above countries. Particularly efficient are power generators manufactured by the Finnish firm Wärtsila. The operational efficiency of such stations in the production of electric power alone is 42 per cent, whereas the combined output of electro-and-thermal power rises its efficiency to 86 per cent, which exceeds world standards for giant power stations.

What makes these generators so attractive is their ecological safety. Operating on natural gas these stations not only keep the air clean, but also save the heat from the diesel engine for heating water via the fundamentally new recuperation system. Let's recall that large thermal power stations and nuclear power stations must always have water reservoirs that take up vast areas of land. Power stations eject hot service water into these reservoirs thus causing the dangerous heat pollution of the natural environment.

The above facts go to show that the high rate of machine-building, increase in the unit capacity of machinery cannot always be regarded as an achievement. Too much harm has been done to our society by the implicit trust of overzealous administrators, technocrats and bureaucrats at our planning bodies and research centres in "rapid growth rates" and "large-scale production". Unfortunately, the virus of gigantomania has infected many of our economic executives and managers at all levels. This is a grievous disease which flourished particularly at the time when the command-administrative methods of management were in their heyday (in the 1970s and in the early 1980s), with lots of sloganeering around various jumbo projects.

This is what Lenin said about the effectiveness of large-scale production. "In industry, also, the law of the superiority of large-scale production is not as absolute and as simple as is sometimes thought; there, too, it is the equality of '*other conditions*' (not always existing in reality) that ensures the full applicability of the law."[1]

Hence it follows that the planning of the rate of development of the machine-building industry, its structure, also the creation of new technologies must be based on comprehensive socio-economic evaluation of its development, with special consideration given to the tasks to be accomplished and to the conditions under which it operates. Of particular importance here is supervision and control of the ecological situation exercised by independent experts.

FORESTRY

> The peoples who, in Mesopotamia, Greece, Asia Minor and elsewhere, destroyed the forests to obtain cultivable land, never dreamed that by removing along with the forests the collecting centres and reservoirs of moisture they were laying the basis for the present forlorn state of those countries.
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> *Engels*

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[1] V. I. Lenin, "Capitalism in Agriculture", *Collected Works*, Vol. 4, 1977, p. 119.

In any country, the forest is regarded as its most important national wealth. Theoretically, it is also highly prized in the Soviet Union, if only in words. Back in 1918, soon after the Great October Socialist Revolution Lenin signed a decree called "On forests", in which he set forth the principal tasks of protection and utilisation of forest as national wealth. In 1977, the government adopted the "Fundamentals of forest legislation of the USSR and the Union Republics". Wherever we may go, be it on railways or on highways, or just having a stroll in a park, we see by now very familiar colourfully decorated posters urging visitors to protect the forest. All that is in our legislation and in numerous appeals by the authorities. But what is actually being done to protect forests from depredation? Unfortunately, there is very little to boast about on this score.

With less than six per cent of the population of the world, the Soviet Union has one fifth of the world's timber reserves (810 million hectares), and holds first place in the world for forest area. This means that there are about three hectares of forest per one citizen of this country. Hardly any other country can boast such wealth! Moreover, according to the same optimistic statistic, the forest area has increased by 64 million hectares over the past twenty years. Every year reforestation work is carried out over an area of 2.1 million hectares. This includes almost one million hectares of newly planted trees. This optimistic picture may create the impression that there is no reason for worry. However, a closer look into the situation shows that there are a lot more problems here than meets the eye. The main source of trouble is the predatory exploitation of our timber resources. The unique feature of the forest as a natural resource is its ability to reproduce itself. However, the forest retains these restorative powers only when people do not interfere with the normal process of recuperation.

The celebrated Russian forest specialist professor M. K. Tursky (1840-1899) who, incidentally, set up a unique forest farm in Moscow near what is now the Timiriazev (formerly Petrovskaya) Agricultural Academy, wrote: "As long as the scale of exploitation of a forest falls short of its natural productive potential there is no shortage of the timber it yields. *But as soon as the exploitation of the forest approaches its productivity limit, it will be necessary to make up without delay what has been take from it, otherwise gradually, the rate of exploitation will overreach its natural productivity which will lead to its uncontrollable exhaustion and inevitable destruction.*"[1]

Incidentally, the above forest farm, which is of great ecological, esthetic and also scientific importance is in danger of destruction, because the architectural planning department of Moscow has developed a project of laying through this unique forest preserve a wide speedway which, if built, will link the centre of the city with Sheremetievo Airport. One need not be an ecological expert to understand that the building of such a motorway would spell destruction for this bit of nature within the limits of this giant city.

The vast forested areas of the Soviet Union may lull our concern for the future of our "green friend". Their exploitation that almost matches the productivity of many forests in this country has long since passed this critical line between destruction and survival. The massive logging operations, the clear-cutting of our forests have badly affected all of our forests. Such operations very often undermine the very principles of forest reproduction, especially in the European part of the USSR and in the Urals where forest is of vital economic, social and ecological significance. Minlesprom and Gosleskhoz (State Forest Management Department) say cynically that "it is not expedient to fell forests in Siberia and transport the timbers across half the Eurasian continent". As a result, the criminal forest cutting in excess of the permissible limit continues in Karelia, in the Arkhangelsk region, in the Vologda, Kalinin and Kostroma regions, also in the Urals, in the North Caucasus, in the Carpathians and in Georgia. In Karelia, for example, a whole 12 million cu m of timber are felled every year, instead of the 8 million cu m, which is its permissible limit. This is what the dynamics of forested areas in the Karelian ASSR looks like:

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[1] M. K. Tursky, *Forestry*, Moscow, Selkhozghiz, 1954, p. 7 (in Russian).

Table 10

Forested Area of Karelia
(full grown and ripening forest stands)
(thou. hectares)

		Out of which	
Year	Total forest area	coniferous forest	hardwood forest
1949	6,497	6,336	161
1956	5,476	5,310	166
1966	4,417	4,243	174
1978	3,917	3,615	309
1986	3,832	3,402	430
1986 in % to 1949	59	53	267

According to the above figures, the total area of full grown forests is shrinking, primarily because of the cutting of coniferous trees. This may soon badly affect forest reproduction. The situation is getting more and more serious because of the rapid cutting of mature tree stands, the weak restorative power of Karelia's forests, and the absence of the necessary measures to speedily restore their resources.

The principle of speedy cutting of full grown and overripe forest stands which so much is being spoken and written about, must always be followed up by no less vigorous reforestation measures. It is necessary to constantly supervise the very process of cutting the excess of full grown and overripe trees in virgin forests. One of the most crucial problems in Karelia in the near future is to bring the intensity of timber cutting in forests in line with their sustained yield in order to meet the needs for timber in the future.

As we mentioned earlier on the volume of timber thus cut is far in excess of that limit and is far ahead of the seeding and planting of forest. Significantly, not only in Karelia, but in fact everywhere in the north-west of the USSR the seeding and planting of new forests is done only in 22 per cent of clearcut areas. However, for normal forest-restoration, according to specialists, it is necessary to seed and plant trees over an area of at least 42 per cent of the clearcut areas. The permissible cutting limit is exceeded over large areas in the Urals. If the present rate of cutting of coniferous forests continues in the Sverdlovsk and Perm Region, they will be totally destroyed in some 10-15 years. The reserves of ripening timber constitutes a mere 8-9 per cent of the forest stands which is half as much as the minimal norm. The Urals are losing their forest cover at a catastrophic speed. The coniferous tree stands are being quickly replaced with aspen and birch. Sites of barren ground and stone where no reforestation is possible are expanding rapidly. Erosion is spreading and the regime of mountains streams is getting more and more disrupted. For example, the tributaries of the rivers Ufa, Silva, Vogulka, and Serebrianka are about half as deep as they were ten years ago, which has greatly affected water supply in populated centres. And, finally, the climate is deteriorating, which, in turn, has a negative effect on the productivity of farm fields.

Forest depletion has reached dangerous proportions in the basin of the Volga. In the Kalinin region, which is the main watershed of the European part of the country, where the River Dnieper and the Western Dvina take their rise, and where the great Volga gains its strength, vast tracks of forest have been put to the axe. The area of mature pinegroves has dropped here down to 10-12 per cent. The rivers are shallowing, the soil is losing moisture. Both the air and water bodies are victims of pollution.

This despoliation is not only the lot of the north-western part of the country, of the Caucasus and the Urals. The malaise has spread to dwindling forests of Siberia. This can be illustrated by the following example, by far not the worst. There is a Soviet-Bulgarian timber cutting and storing enterprise (Udorski tree farm) operating in four villages in the Komi autonomous republic. This enterprise, called Mezenles, employs almost seventeen thousand Bulgarians.

When looking down from an airplane one can easily identify this place by the snow-bound squares of clear-cut forests. This gives thought about the future of forests in these parts. Scientists, sylviculturists, forestry specialists place great hopes on the undergrowth here. It is this undergrowth, which, if it survives, must grow up to be a forest. But this is only if the techniques of timber cutting and other requirements are observed, if the young coniferous trees are protected against fire, etc. However, in modern practice all that is nothing but wishful thinking. No proper attention is given to forest regeneration. Nowhere are the mutual Soviet and Bulgarian commitments recorded. All these things are particularly important in the conditions of the North. It is necessary, in the first place, to create seed-breeding complexes complete with nurseries for plants of the forest, to have modern machines for preparing the soil for tending these plants and the soil on which they grow. So far, however, everything boils down at best to conserving the natural undergrowth.

The results are discouraging: in the Udorski tree farm the area of such tree nurseries has diminished greatly over the past thirteen years. Elsewhere in that region where pinetrees and firtrees have been logged indiscriminately the lost tree stands (22 per cent of the total) has been made up for largely by birch trees and aspens and some other less valuable softwood varieties. In other words, the northern forest is getting scantier every year.

The future of the Siberian cedar pine inspires the greatest concern. It is being mercilessly chopped down in Central Siberia, in the Altai region, and in the Soviet Far East. For the loggers who are primarily concerned about the volume of wood thus stored up, this giant tree is a real bargain. And nobody ever gives thought to the fact that this tree becomes a fully grown plant only at the age of 200, and that for six centuries thereafter it yields cedar pine nuts which have rare nutritional and medicinal properties. One can judge the loss from the following figures: in 1912 the Russian taiga yielded 220,000 tons of cedar nuts whereas in the 1960s only 8,000-10,000 tons of cedar nuts were collected, and in 1986 a mere 2,500 tons.

The most outrageous aspect of the existing practice of logging is the fact that in many cases the volume of timber cutting is a goal in itself to be achieved for the sake of fulfilling the bureaucratic plan. It often happens that later this timber rots away during transportation and rafting. The practice of drift floating continues, in spite of the fact that this method has long since been prohibited. The bureaucratic formula "as an exception" is still very widely practiced, and Minlesprom still favours this cheapest (for the ministry, and not for the natural environment or for the nation!) method of transportation on many rivers of the North and of Siberia. As a result, this method costs the nation 85,000 cu m of timber a year. However, the ministry regards this figure as a great achievement: after all back in 1960 the nation lost 3,000,000 cu m of timber. Siberian rivers are literally rolling their waters over timbers. Their bottom is covered not with stones and pebbles, but with wood! What could one expect if in the year 1986 alone about 144,000 cu m of sunkers were lifted from the bottom.

The loss of forests in the reservoirs of hydroelectric stations has a long history that goes back to the building of the Rybinsk Hydro. The Rybinsk "sea" as it is often referred to, has flooded not only millions of hectares of forestland and arable land, but also hundreds of Volga-side villages with their orchards and ploughfields. Also submerged are the ancient Russian towns of Kalyazin, Maloga, Yurievets. That was at the time of the war with Nazi Germany. Our country, including our defence industry, was badly in need of electric power which had to be obtained at any price, whereas the country's technical potential was at the time rather low. So you might say that it was a great yet justified sacrifice.

But as time went on, the industrial potential of the Soviet Union increased, the Soviet economy developing in the conditions of peace, but the vicious practice of forest destruction by raising highdams continued. The Rybinsk sea was followed by the Gorki sea, the Kuibyshev sea and some other reservoirs on the Volga which led to the destruction of forests, meadows and farm fields. This vicious practice reached its peak in the construction of the power giants on the rivers of Siberia. Many people remember the enthusiasm with which highdam builders were "conquering" the river Angara. On this river the Bratsk Hydro was built and, together with it, the man-made Bratsk "sea". What jubilation! I, too, went to the shores of this "sea". I remember cheering crowds. I looked down upon the "sea" and watched whole islands of monstrously entangled roots and branches of giant Siberian pines, firs and larches, gliding over its surface. According to forest experts, 35 million cu m of forest, largely consisting of precious tree varieties, remained on its bottom. Also flooded were loggers' camps and even a section of the railway which had been built specially for shipping timber out of the flood zone. The builders of the Krasnoyarsk Hydro re-enacted the fallacies of the Bratsk highdam.

One could expect that the sad experience of the high-pressure construction of hydro-electric stations built expressly for the purpose of sending glorious-sounding reports to the local and central authorities on its progress achieved at the price of the irredeemable losses for both nature and society, must be properly studied and taken into account. This experience was indeed taken into account by such mighty departments as city building authorities and timber storage administration except that it was done in their own purely bureaucratic fashion.

When work began on the construction of the Sayano-Shushenskaya Hydro on the River Yenisei, Minlesprom and Minenergo showed remarkable unity in circumstantiating and defending their idea of flooding the standing forest. These two ministries were supported by a relevant commission of the State Building Committee which succeeded in excluding from the building estimates all expenditures on forest cutting and timber removal. The relevant documents give the impression that there was no forest of any kind on the bottom of the future "sea".

Executives of Minlesprom greatly contributed to this "wise" decision. The arguments they used were as follows: the forest grows on the steep sides of the banks, with no roads on them. This means that the chopping down of such forests would bring the ministry nothing but losses. So why bother?

Now let's see how this "wise" decision has worked. The results are as clear as daylight. All the coves and estuaries of rivers and streams, of bays and harbours and the entire area upstream from the dam are now clogged up with floating trees. Every summer the man-made sea plucks them out of the bottom.

Here is a document adopted by a body of experts concerning the construction of the Sayano-Shushenskaya Hydro. It reads: "Trees, brushes, stamps create serious obstacles to the exploitation of the hydroelectric station, thus reducing the output of electric power. No speed boats are allowed to sail on the reservoir, and the freight and passenger fleet has markedly restricted its operations. The ecological regime of the reservoir has been disrupted, and its recreational potential is going down. The supply of water to newly-built industrial and other facilities is deteriorating."

The project executives of the still unfinished power station sounded the alarm, and they had reason. No sooner had the fanfares over the launching of the first power units died away than they were beset by various technical defects. Now one unit, and then another fell 5-7 per cent short of their designed power-generating capacity.

This happens because the guard-grill at the water intake upstream from the turbines was clogged up with driftwood. Frogmen had to go under water to remove the blockage. The problem was complicated by the fact that the Sayan reservoir is very deep and the pressure from the water head plugged up the feeding channel with trees which were much more water-logged than usual. Even the pinetrees lost their buoyancy. Torn from the ground the timbers, complete with roots and crown, float towards the dam, 25-40 metres under the surface at the level of the water intake openings. That is why they get clogged up at working levels. This is the result of the use of the new technology. Those are the consequences, in addition to the loss of the forest, of the attempts to "economise" made by the timber storing departments. And again, as usual, the ill-fated experiment failed to teach our overzealous economic managers anything. We are facing similar problems with the Boguchanskaya hydroelectric station on the Angara which is currently under construction.

This is what a *Komsomolskaya Pravda* correspondent saw as he flew in a helicopter over the bed of the future storage lake at the end of the summer of 1988: "Down below passed islands with beautifully sounding names—Turgeve, Sosnovy—all nibbled at the edges and piled over with birches and firs. I could hardly believe my eyes. All this shambles was officially called 'the cleanest floor of a future storage lake'. This epithet was used in our newspapers particularly often since then. It was precisely at that time, on the eve of the 70th anniversary of the Great October Socialist Revolution, when the Angara was blocked (for the fourth time, I think) and at a press conference the leading Soviet hydraulics specialists repeated again and again those very words 'the very cleanest of all'. That oft-repeated 'very very' was yet another six million cubic metres of abandoned, stunted trees which will most likely end up in bonfires blazing on the banks of the Angara."

There are still more grandiose projects, such as the construction of the Middle-Yenisei and Turukhansk hydros. Besides cutting standing timber the builders of hydroelectric stations also destroy the already stored up timber by manipulating the stream any way they please. Here is an illustration of how they keep their promise to protect the population and their property from harnessed rivers once they get out of control. In the rainy summer of 1988 the builders of the Sayano-Shushenskaya Hydro dumped an excess of water from the storage lake so as to prevent flooding in the upper reaches of the Yenisei. A similar operation was carried out at the Krasnoyarsk Hydro. The pressure of the water thus increased nine times over to 11 cu m per second. This avalanche of water wiped off the annual stocks of timber at the Krasnoyarsk saw mill and at the timber-portage centre and carried them downstream. One such day brought to naught the entire stocks of timber stored up over the winter worth four million roubles. Altogether the damage was assessed at about twenty million roubles.

Wood-processing is also a very wasteful operation. Suffice it to say that due to the numerous imperfections of the entire system of production, also the backward technology only 60-65 per cent of the wood stocks are put to good use, with the rest of the woodmass lost in the various stages of processing. Every year the volume of wasted wood runs into hundreds of millions of cubic metres.[1] The following example illustrates the situation created by the wood processing industry in the Krasnoyarsk region. For twenty years now about one million cubic metres of slab, sawdust and chip have annually been taken out of town and set alight. The layer of woodwaste in the city dump is seven metres thick. It is hard to tell the size of its territory because the smoke blots the rest of it from view. Once plans were afoot for the construction of a hydrolysis plant (according to some computations it would have by now yielded ten billion roubles worth of profit). It was also planned to build a pulp-and-paper mill, a furniture factory operating on wood waste (every year 40 million roubles worth of furniture are brought into Krasnoyarsk region). Instead of that all we see is a giant dump, one huge bonfire.

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[1] What we lose in the process can be judged from the following figures. The sawdust and other materials can go into the making of fiber board used in construction. One million sq m of such board can substitute for 16,000 cu m of sawtimber, the production of which requires 54,000 cu m of wood. This is equivalent to a coniferous forest felled in an area of 300 hectares.

The main idea of Minlesprom is to store up as much wood and sawtimber (the simplest and cheapest of forest products!) as possible. The Soviet Union is far behind the industrially advanced nations in techniques of exhaustive wood processing and in the production of the most economical types of timber products. For 1,000 cu m of wood logged in the Soviet Union and the United States the latter produces 6.2 times more paper and cardboard, 9.6 times more plywood, 1.7 times more particle board, and twice as much fiber board. Being first in forest resources, in the export of commercial wood and for the production of sawtimber, the Soviet Union holds only fourth place for the absolute amount of paper and cardboard produced, and 42nd place per capita in the world.

Now special mention should be made about the environmental pollution caused by the woodworking industry, and especially the pulp-and-paper industry. Our water bodies suffer the greatest from the production of paper and cardboard. Among them such giants as lakes Baikal and Ladoga, the rivers Northern Dvina, Pechora, Kama and Kolyma.

You may wonder how Minlesprom can make such a weighty contribution to environmental destruction? All that is very simple. According to former minister M. Busygin, a mere 16 per cent of industrial establishment in this industry were built after 1960, and a mere 26 per cent have since been reconstructed and retooled. All the others were put into service either at the end of the last century or early in this century.

The programme of this ministry provides for stopping the dumping of untreated effluent and for reducing the toxic content of gaseous discharge into the atmosphere by 1995. Vigorous actions are needed to materialise the programme.

Of special significance is the development of an integrated comprehensive, specific long-term programme for reforestation and for the development of the entire wood-working complex. This programme should provide for expanding the area of tree nurseries. This aspect of the problem is rather important, although it is not the most important one. Central to the whole programme is the reduction of forest cutting, the problem of more intensive processing of forest material, including deciduous wood, boughs, bark and stumps, and waste material from saw mills and woodworking factories. Particular attention should be paid to waste material from paper. In such countries as the United States, Japan, West Germany — more than half the paper produced comes from waste paper. In the Soviet Union, by contrast, this valuable secondary raw material literally goes to waste and pollutes the environment.

In this respect it is very important to study and indeed draw on foreign experience, notably that of our northern neighbour, Finland. Very interesting in this respect is the activity of the biggest Finnish company, Rauma Repula which draws its raw material from forest and sea. According to one of the company directors, Erkki Karppinen, forest means not only wood, but also its deep, and practically waste-free processing. The final product is high-quality pulp and paper. This company has its own woodlands where all the cutting is done selectively, only of trees of certain degrees of maturity. This means that the woodlots here are in continuous use.

Most of the wood used by Rauma Repula is imported from other countries, mostly from the Soviet Union. Finland is known for its beautiful forests. Its pulp-and-paper mills are equipped with modern machines manufactured at one of the plants belonging to the same concern. It is worthy of note that over 30 per cent of the paper here is manufactured from birch.

Now briefly about the economic aspect of Soviet forest utilisation. Every year our country exports 18 million cu m of timber, 8 million cu m of sawtimber and 0.4 million cu m of plywood. Significantly, the most precious varieties of timber, such as the Sayan cedar pine and the larch are exported at 52 roubles per cu m. Prossessed timber such as structural parts for houses made of the same timber are 5 or 8 times as expensive.

The so-called "by-values" of the forest is a subject of high utility. The very definition of "by-values" reflects the old bureaucratic way of regarding the forest as a mere source of wood material. Everything else is considered unimportant.

It is true that forests are rich in the fruits of nature, although their number is dwindling rapidly. This is easy to see if we take a look at our forests and then at the counters of our food stores. Oranges from Africa are almost a common sight, apples from Central Europe and China, too. The same could be said about the half-a-metre long cucumbers with their Asian pedigree. But try and see if you can find in food stores, be they state-run or cooperative, ordinary cranberries from northern Russia. You won't find them! Berries have become a rarity at any price!

But why? Have all of our bogs dried up? Not all of them! According to some estimates, about one and a half million tons of cranberries grow there every year! And if cranberries, just like bilberries and cloudberries, also saffron milkcaps and peppery milkcaps, have become exotic, it is owing to our inability to make wide use of the treasure-house of our forest. All that grows and lives under the gracious canopy of the forest — animals and birds, mushrooms, nuts and medicinal herbs — in the opinion of timber authorities, is a trifle which is not worth the trouble, particularly since it takes so much effort to get it. All the more so since, in the opinion of our planners, the conservation and utilisation of this treasure is nothing but a whim, or fun at best.

But is this really so? Surprisingly, the non-timber products of the forest are its principal wealth. Even in terms of money their total value is higher than the value of the timber, to say nothing of the ecological and nature conserving value of the forest. According to an estimate made by A. Cherkasov, the head of the laboratory of the

Kostroma forest experimental station, the amount of edible mushrooms comes to about 5 million tons, cranberries somewhere around one million and a half, and as much cowberries. And the bilberries which is so highly prized in this country, to no less than three million tons. There are also other delicious berries such as bag whortleberries — raspberries, currants, rosehips and mountain ashberries. To say nothing of medicinal herbs! What a treasure! It is clear that all these blessings are hard to come by. But even if these figures were halved (due to difficulties involved in handling the berries) the gifts of the forest would still be tremendous. Actually we make use of a mere 23 per cent of the mushrooms, and, at best, five per cent of the cranberries...

True, practically nothing gets lost near large cities. It would also be unwise to deprive people of the pleasure of mushroom and berry hunting. At the same time the practice of purchasing forest products in out-of-the-way places has stopped. It's time we set up a planned, well organised system whereby vacationers and camping school children in areas rich in berries could harvest these and other valuable plants. Another way of tackling this important problem is to encourage the families of forest wardens to take in harvests of forest plants.

In Finland, for example, local firms that engage in storing up the fruits of the forest make use of the information supplied by forest plant watchers who furnish information about the time when berries bloom and ripen, where they are expected to grow in abundance, and where berry collectors should be sent in.

We must also have a similar approach to the wealth of our forests. Our scientists have worked out a system whereby berry harvests can be sized up. When such data are plotted on the map, the purveyors will have the exact addresses where volunteers could be brought closer to berry patches. Also berry storage centres should be set up right there. It would be unwise, for instance, to set up such centres some 10-15 km from the nearest cranberry swamp. Just try and carry two pails full of berries over this distance! In other words, as often happens in this country, organisation is lacking. It looks like Goskomles (State Committee for Forest Management) has a job cut out for them. It seems that cooperative forms of work could be turned to account.

3. Industrialisation of Farming—the Road to Ecological Disaster

> No other sphere of activity calls for weighing so many pros and cons in order to achieve a success, nothing else requires such a wide range of information, and nowhere else does bigotry lead to such a dismal failure as in agriculture.
>
> *Klement Timiryazev*

Agriculture plays a key role in the rapid socio-economic progress of this country, because its development is at the root of the wellbeing of our society. Suffice it to say that about 3/4 of all goods consumed in this country come from agriculture. Agriculture is not only the largest sector of the national economy, but also the nucleus of the entire agro-industrial complex (AIC) of the Soviet Union. The AIC (including the industries that supply it with the means of production) provides for about one third of the overall gross social product, for all fixed production assets, and for one-third of the labour force. Moreover, agriculture accounts for 49 per cent of the overall amount of production within the agro-industrial complex, 72 per cent of its production assets and 73 per cent of labour.

Over the past two decades the Soviet state allocated for agriculture vast material, technical and financial resources as can be judged from the following figures.

Table 11

Material, Technical and Financial Resources of Agriculture

Indicators		1970	1980	1988	Percentage of 1988 to 1970
Capital investments	billion roubles	19.9	36.8	51.4	260
Fixed production assets	billion roubles	106	238	346	326
Power capacity	million hp	322	604	750	230
Artificial fertilizers	million tons	10.3	18.8	27.2	264
Electric power	billion kwh	38.5	110.9	168	438

Indicators		1970	1980	1988	Percentage of 1988 to 1970
Irrigated land	million hectares	10.8	17.2	20.5	190
Arid land	million hectares	10.2	16.9	19.8	191
Gross agricultural output	million roubles	168	188	220	131

The above shows that the main elements of the material and technical base of agriculture in the said period grew 2-4 times over. At the same time its gross output grew comparatively little.

In this situation the 27th Congress of the CPSU stated that "We must achieve a breakthrough in the agrarian sector so that already in the Twelfth Five-Year Plan period, we shall be able to markedly improve our food supply." A successful solution of this very complicated problem calls for a detailed economic analysis of the reasons for the unsatisfactory development of agriculture and for taking measures to envigorate it.

This analysis shows that the widely discussed explanations for failures in agricultural production (poor material and technical base, and unfavourable climatic conditions) are as a rule rather superficial and therefore not convincing. The inadequacy of such explanations is attested by the very dynamics of growth of agricultural production. In the eighth five-year plan period (1966-1970) the average annual volume of farming output in the country grew by 21 per cent, in the ninth five-year plan period (1971-1975) by 13 per cent, in the tenth five-year plan period (1976-1980) by 9 per cent and in the eleventh five-year plan period (1981-1985) by a mere 5 per cent. A comparison of these data with the figures listed in the table shows that during the eighth and ninth five-year plan periods our farming industry was equipped down to a half and even down to one quarter of what it was in the eleventh five-year plan period, and the average annual rate of growth of farm production was correspondingly 2.5-4.0 times higher. The average weather and climatic conditions over the said periods had not undergone marked changes. Consequently, the actual reasons for the slow-down in

Our ancestors knew how to combine their creations with the beauty of nature (Staritsa convent)

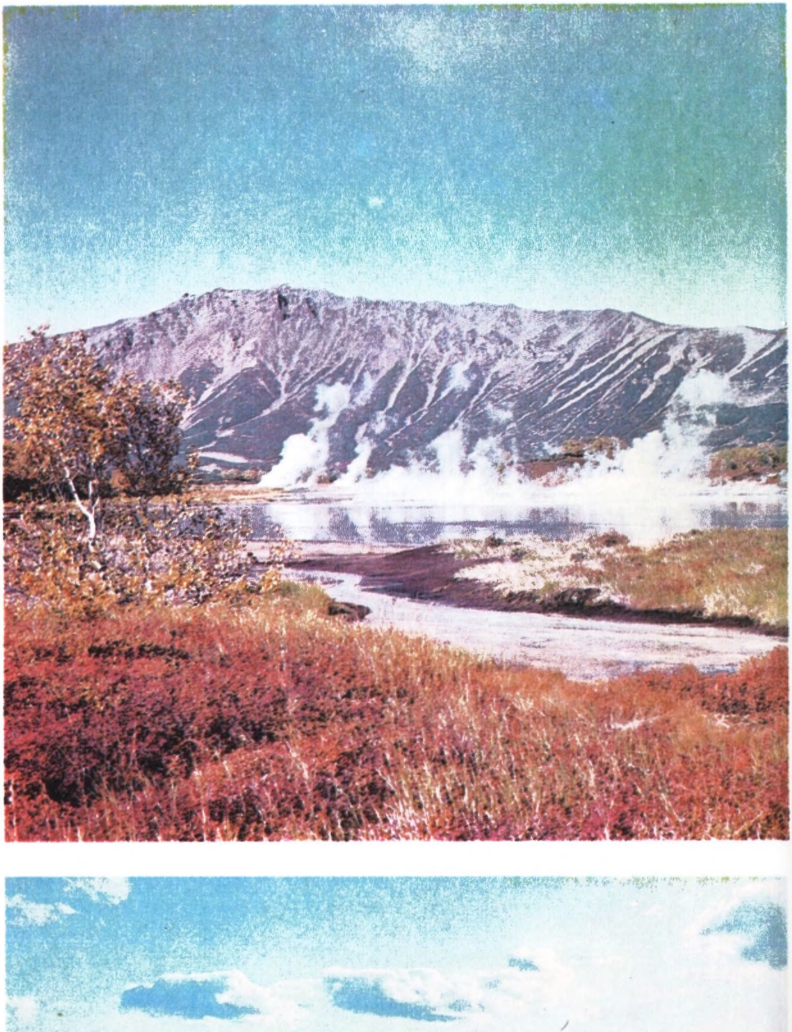
Today we show a criminal indifference for both the beauty of nature and the creations of our ancestors (Valaam Island)

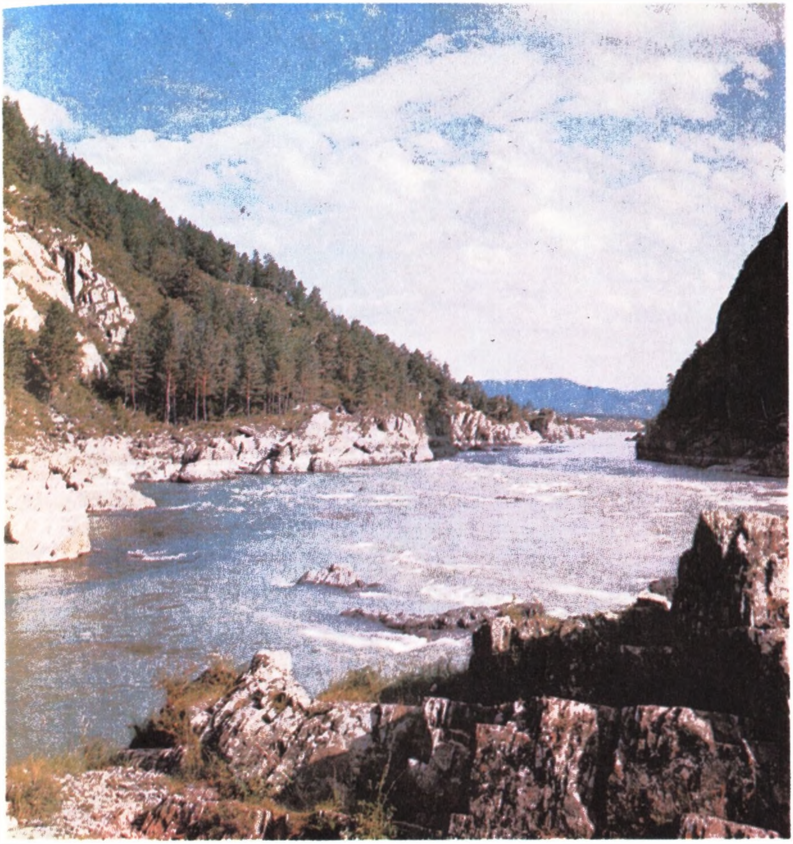
Historical amnesia: from total oblivion...

...to militant sacrilege

Vast areas of precious farmland and forests are flooded (near the Rybinsk storage lake) by reservoirs

The water in such reservoirs is stagnant and begins to bloom. Rivers lose their ability of autopurification (Kiev storage lake)

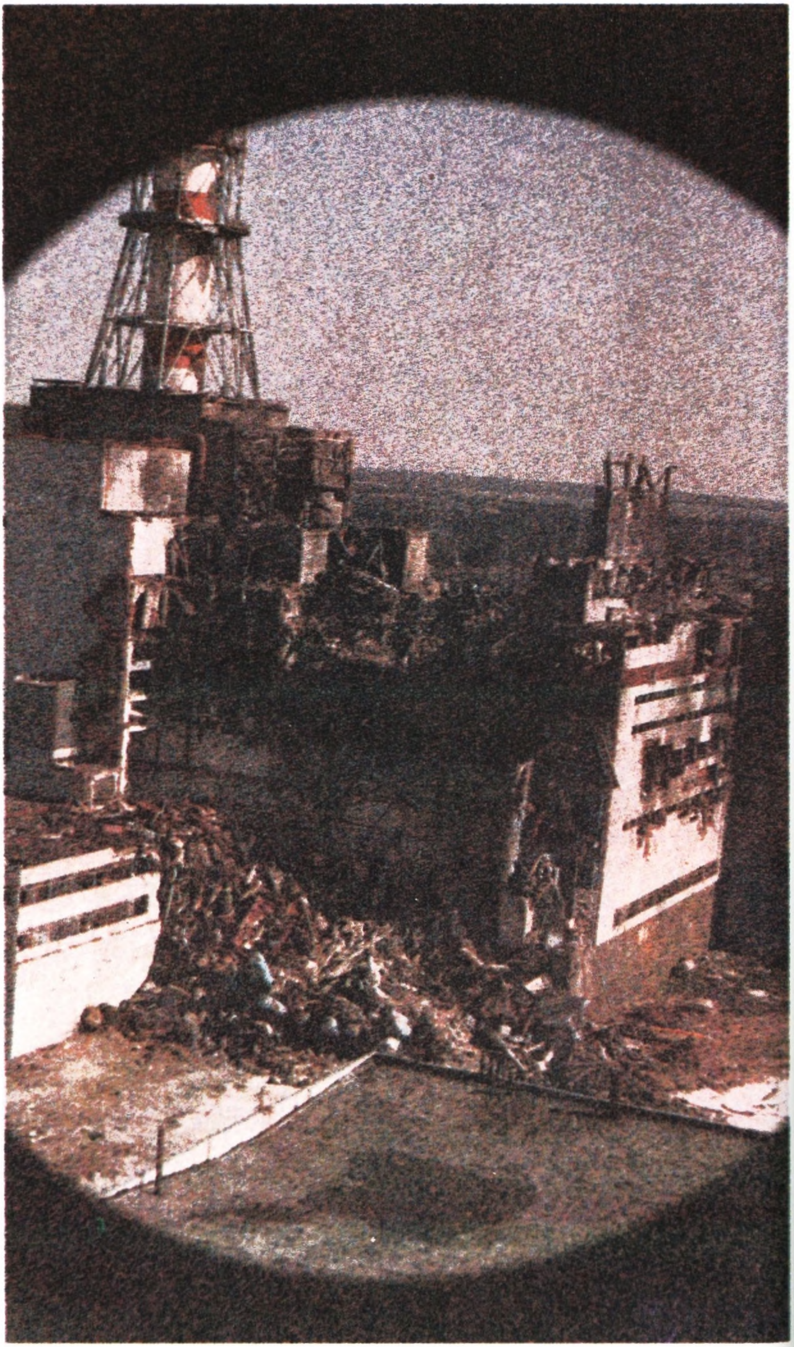




Altai. The confluence of the rivers Katun and Chemal. The Power Engineering Ministry is planning to build a giant reservoir here

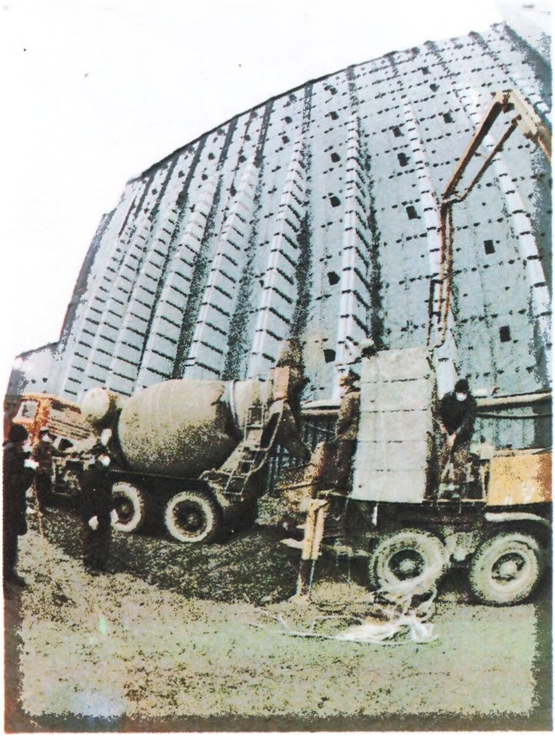
Renewable sources of energy have a vast power potential Geothermal waters in the Valley of Geysers in Kamchatka

The Kiev hydro-storage electric power station, the only one of its kind in the Soviet Union



This tree beside the road to Pripyat was killed by radiation

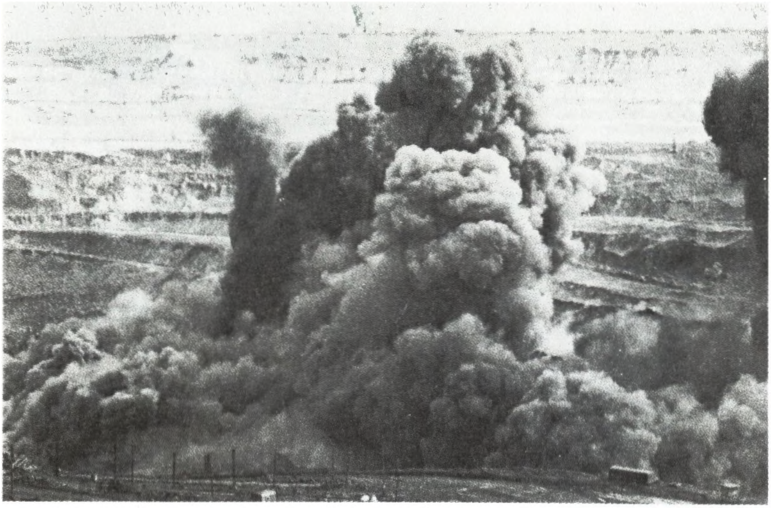
Nuclear power industry. Chernobyl: a stern warning
A view of No. 4 power unit at the Chernobyl nuclear power plant shortly after the accident. This picture was taken from a helicopter



By the beginning of 1988 the damage inflicted by the Chernobyl accident was assessed at 8 billion roubles. A 30-cm thick layer of earth was stripped and buried on the grounds around the Chernobyl nuclear power plant

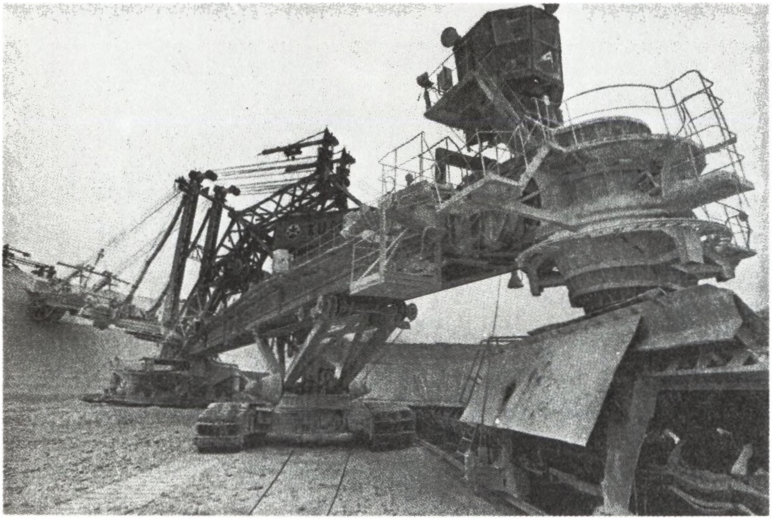
The final stages of the construction of the sarcophagus over the accident-stricken No. 4 power unit of the Chernobyl nuclear power plant

The process of mining deprives the earth of millions of tons of rock annually

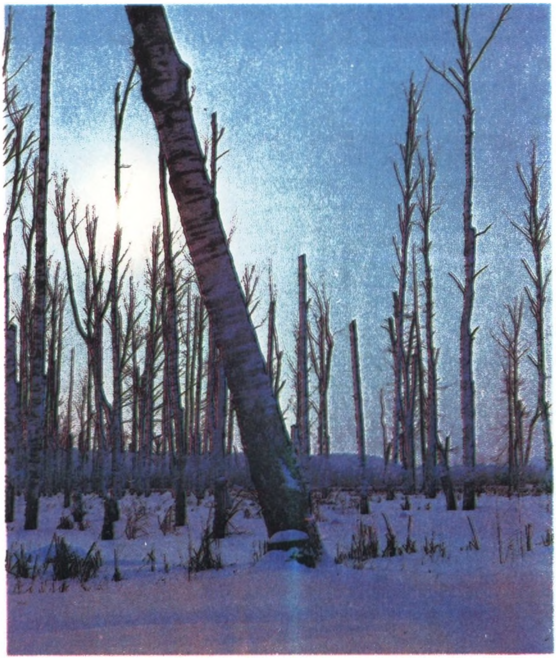


The Kursk Magnetic Anomaly. Blasting operations in the Stoilenski quarries (Belgorod region)

Nature destruction hardware is getting more and more sophisticated. The rotary excavator in the Stoilenski quarries



Such scars on the body of the earth will remain unhealed for a long time. (General view of the Stoilenski quarries)



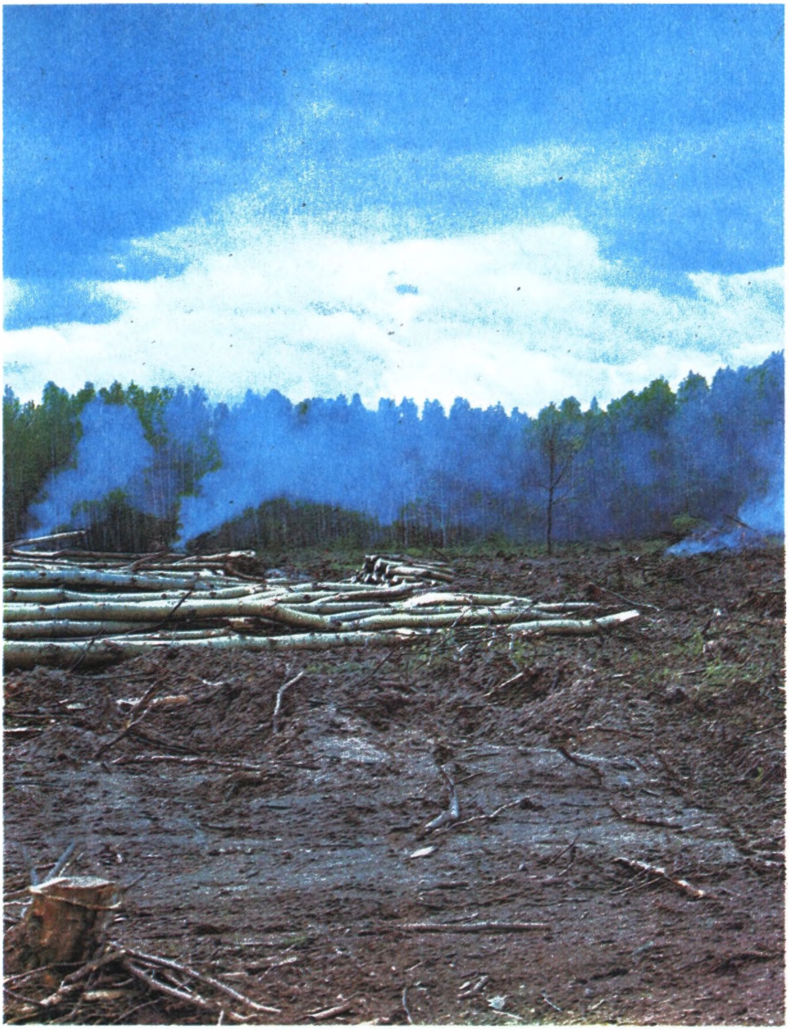
Withering trees around the open-cast areas

Non-ferrous metal plants are a dangerous source of environmental pollution. The town of Alaverdi in Armenia

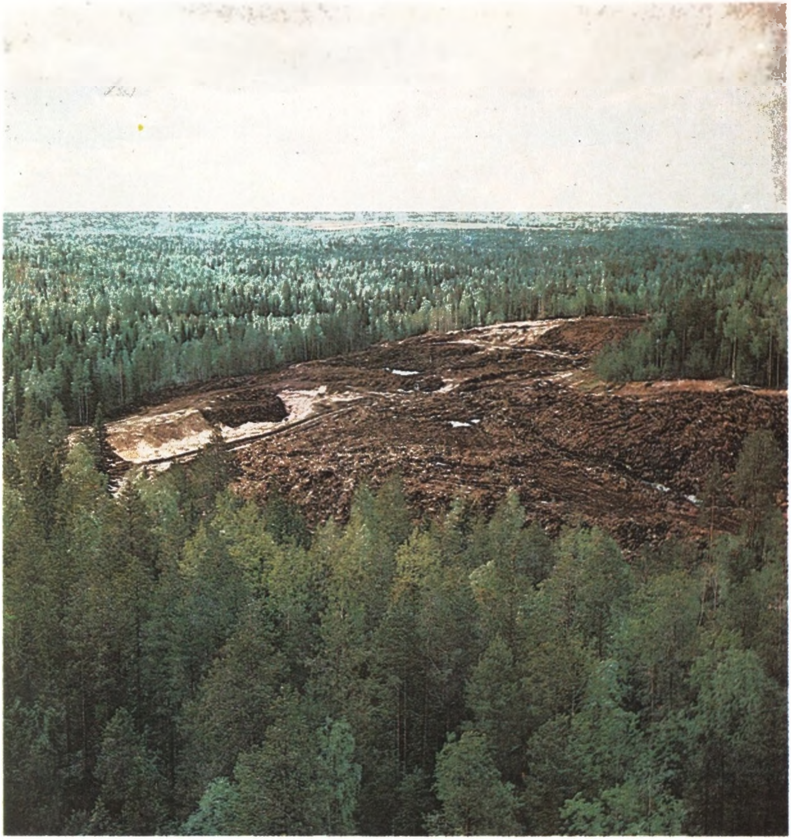
Piles of discarded metal:
Abandoned hardware and various metal structures on the outskirts of a large industrial city

Hundreds of thousands of fuel canisters in the newly developed areas of Siberia

City dumps. There is a lot of metal and other important materials waiting for their chance



An anthology of mismanagement:
After clear-cutting the area remains littered with cutting waste



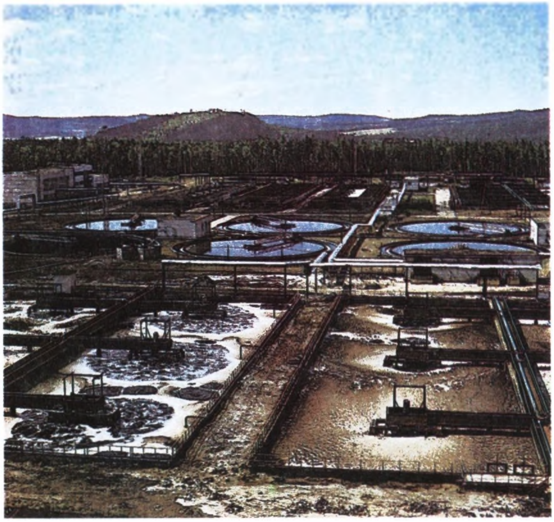
Wood processing leaves a lot of waste material behind (dry tree bark on the grounds of the pulp-and-paper mill near Syktyvkar)

Timber cut "to meet planned targets" is often left rotting in the forest

A dangerous ecological situation has developed in cities where pulp-and paper production is located (Bratsk)

Timbers destroyed in rafting (Bratsk storage lake and the pulp-and-paper mill)

Depressed forest on the banks of Lake Baikal near the Baikal pulp-and-paper mill



The pulp-and-paper mill at Ust-Ilimsk. This is one of the few examples of how progressive technology can be properly used in the production of wood pulp and for purifying industrial effluent

If used thriftily this "green storehouse" can be used forever...

...and cheer our hearts with its pristine beauty

Ploughing must be done with an eye to possible water erosion...

...or it may be done in defiance of it—nearly till water edge

A doomed village

Without a master houses go derelict...

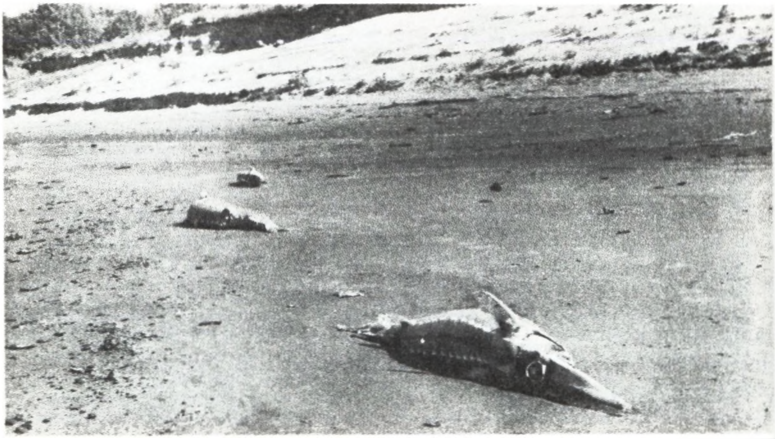
...and so does the land. This ploughland will yield nothing

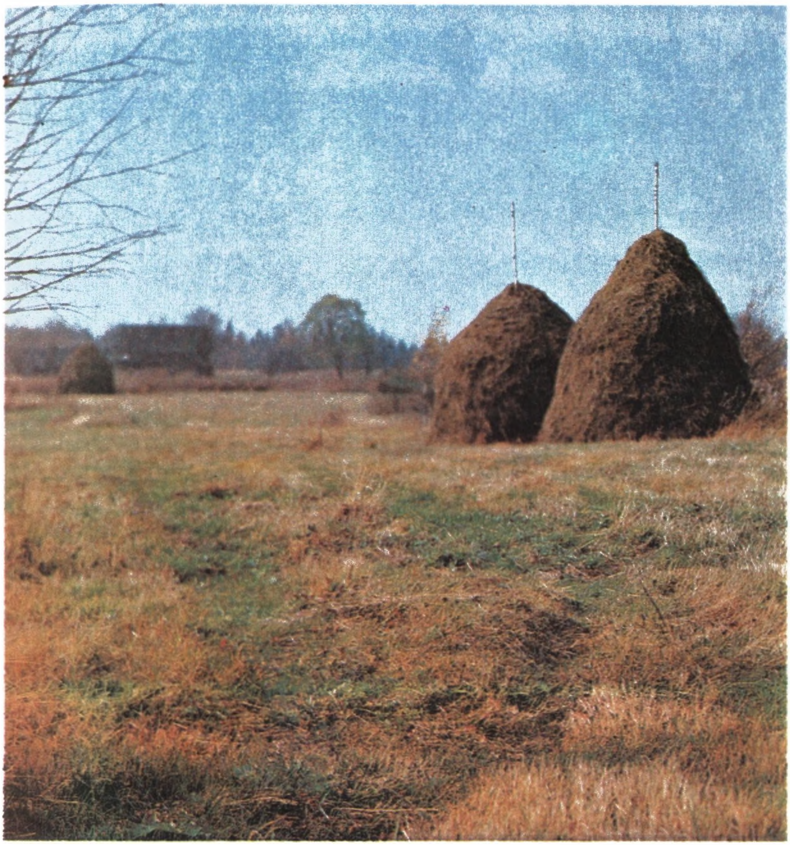
Farm machines manufactured by the *Rostselmash* plant.
Its motto could sound: "quantity before quality"

The consequences of the inordinate farming mechanisation and mismanagement

Transportation and storage of pesticides are often done without observing the necessary safety rules

And this is how mineral fertilizers are often disposed of right in the field





Vast areas of natural pastures in Russia are flooded by storage lakes or not used at all. The policy is to use factory-made feed

Pesticides: better take them to the dump, rather than to the field

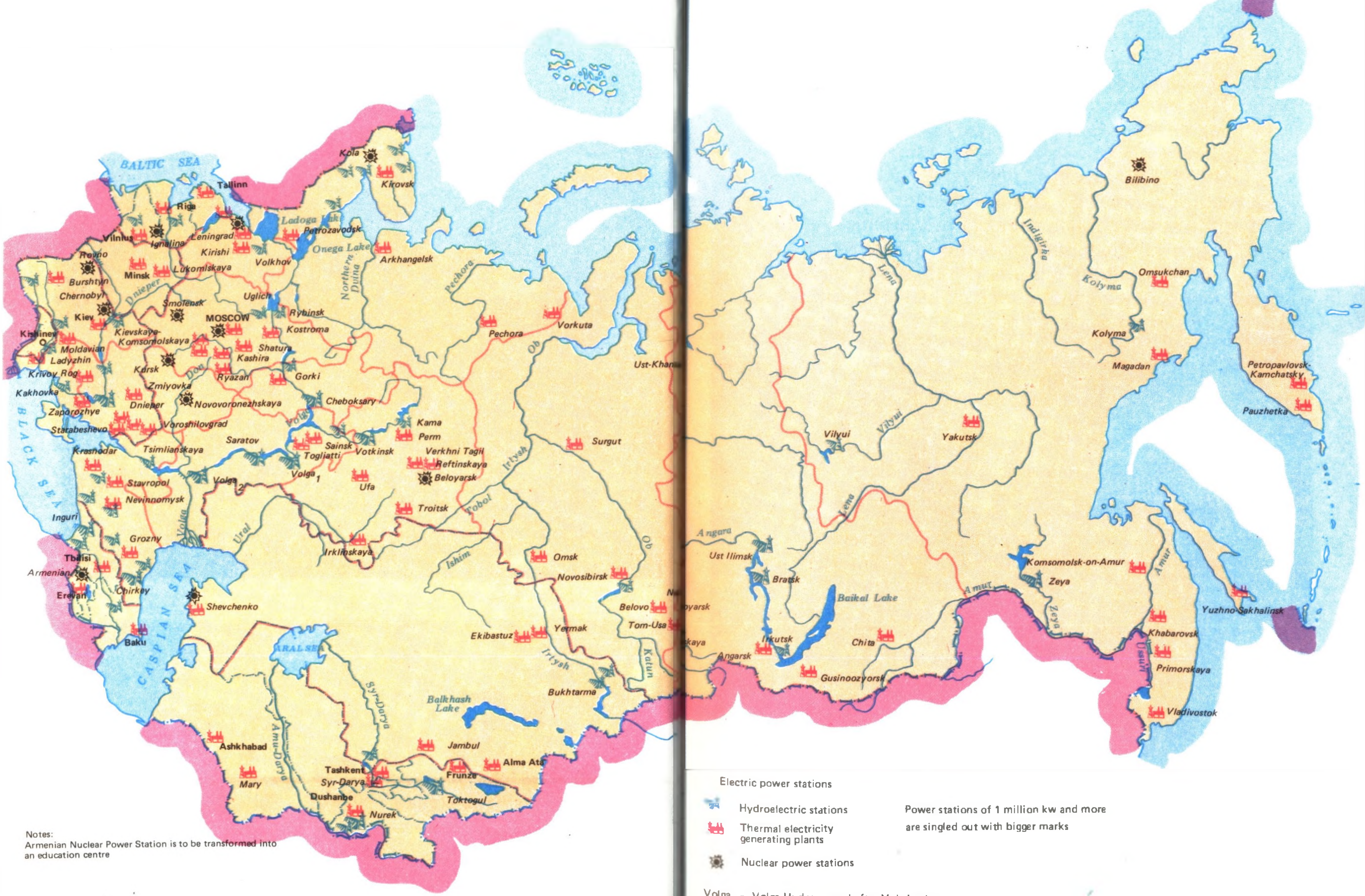
Chemical contamination of the water often leads to the death of fish in rivers. Sturgeon perished in the lower reaches of the Volga

This village still has a chance to survive

This is how soil amelioration starts

MAJOR BRANCHES OF SOVIET INDUSTRY POLLUTING THE ENVIRONMENT

1 POWER INDUSTRY



Notes:
Armenian Nuclear Power Station is to be transformed into an education centre

Electric power stations

Hydroelectric stations

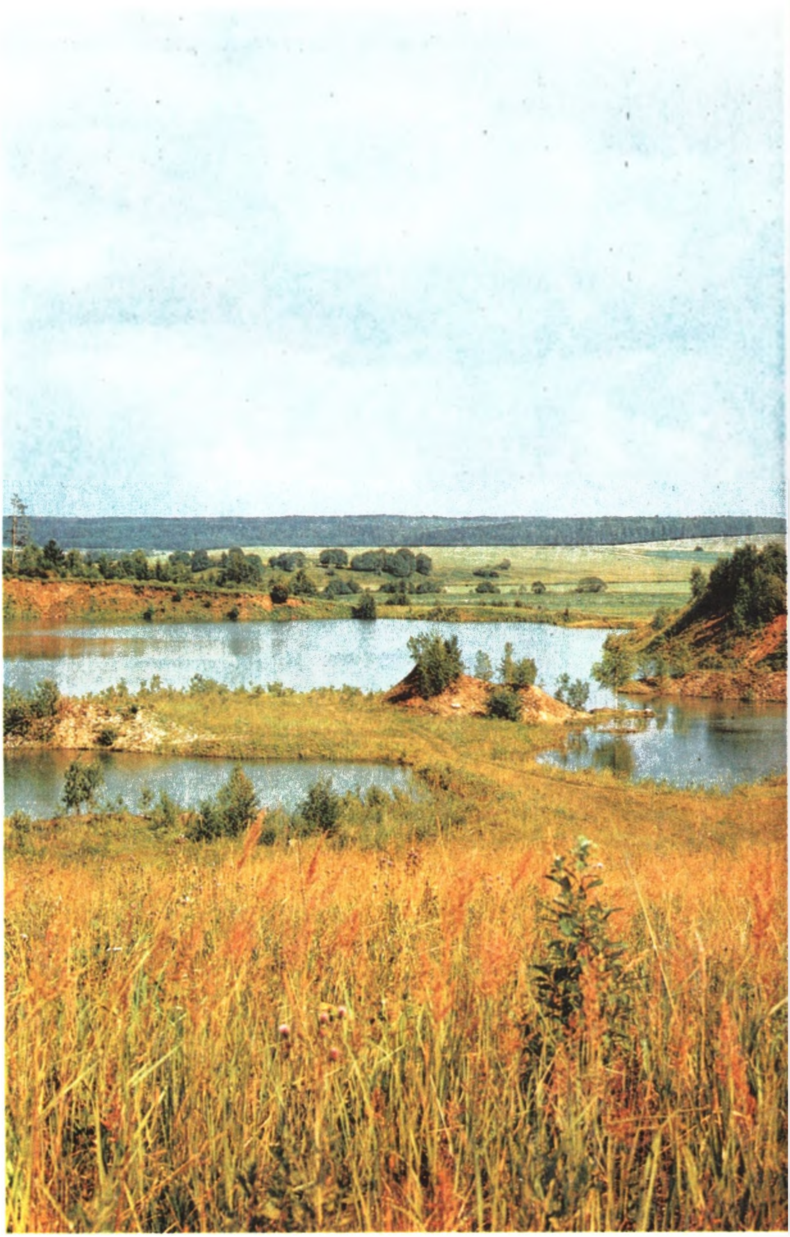
Thermal electricity generating plants

Nuclear power stations

Power stations of 1 million kw and more are singled out with bigger marks

Volga₁ – Volga Hydro named after V. I. Lenin

Volga₂ – Volga Hydro named after the 22nd CPSU Congress



Recultivation of an abandoned gravel guarry in the Smolensk region the rate of productivity growth in our agriculture lie elsewhere. So what are these reasons?

A comprehensive analysis of the interaction between the factors of growth of agricultural production from the positions of the systemic approach shows that the *problem is rooted in the insufficient attention given to the re-production of the natural-resources potential of agriculture.* It is well-nigh possible to find an agricultural worker at our planning organisations or research institutes who do not know that no *land* is the principal factor of production in agriculture. Any text-book on agronomy says that. To maintain and increase soil fertility is at the back of all measures to increase productivity in agriculture.

In actual practice, though, the solution of this fundamental question has for a long time been relegated to the background. It was assumed that farm productivity would be increased by way of pushing the development of the three main elements of agriculture: mechanisation, chemicalisation and soil amelioration. These factors are responsible for intensifying agricultural production but with one condition in mind, which is the consistent utilisation of the achievements of scientific and technical progress in these spheres.

Scientific and technical progress in agriculture is to this day viewed primarily in terms of quantity, such as the growth of *mechanisation*, *chemicalisation* and *soil amelioration*. This is essentially a technocratic approach from the positions of extensive, cost-boosting method of the development of production. The one-sided understanding of intensification as a mere increase in the mass of aggregate (living and embodied) labour in the same production area, such as a plot of land, a stock-raising farm, etc., has gained currency. Moreover, the advocates of this point of view, though they refer to Marx and Lenin about the concentration of capital on one and the same land area when intensifying farm production, equate a greater labour input with intensification itself.

For example, professor I. Suslov, in one of his latest publications writes: "The more chemicals and technical means are used at a production unit, in a region, in agriculture as a whole, the better the qualitative characteristics in the development of the forces of production, and the higher the degree of intensification of production in a particular branch of the national economy as a whole. Therefore the growth of the forces of production in agriculture through more investment in its mechanisation, amelioration and chemicalisation can rightly be attributed to the intensification of development of a given branch." The above statement shows clearly that this cost-intensive approach to intensification of production is unacceptable in modern conditions. Regrettably, this approach has until recently been the key to the assessment of the intensification of social production.

The following few examples show the damage that this approach has done to our farming. In accordance with the requirements of the overall cost-intensive approach which treats mechanisation of farming merely in terms of increasing the capacity of agricultural machinery, the machine builders go on designing increasingly powerful and bulky tractors and grain harvesters the manufacture of which has put the Soviet Union ahead of all other countries. Of the 595 thousand tractors manufactured in 1986 about 145,000 had engines with a power capacity of over 100 hp. Among them are giants like 150 hp T-150K and 200 hp K-700 tractors. These monsters consume much fuel, and their great weight destroys the top soil. At the same time they have no optimal set of mounted and trailed implements that would fully engage their potentialities. As is known, farmers use different implements for different farming operations such as harrowing, soil cultivation, sowing, introduction of fertilisers, harvesting, removal of harvested crops and straw, also land ploughing, and many other agricultural operations. The oftener such a tractor moves across a farm field, the harder it packs the soil, demolishing its structure, disrupting the water and air regime in the top soil. It also damages the plough layer, depresses the vitality of the useful microflora, and consequently, reduces soil fertility, especially in the loams, in the *podzol* and black earth.

Instead of correcting this abnormal situation, the Kirov

Plant has started production of a still heavier K-701M tractor. And that at the time when more and more garden tractors are being manufactured practically all over the world. In 1986 the United States produced 664,000 such tractors, Japan 268,000, China 773,000. In that same year the Soviet Union produced a mere 55,000 garden tractors which fell far short of the growing demand for this machine (considering the fact that a certain proportion of such tractors are exported).

So it happens that a light, manoeuverable, ecologically safe farm machines are in short supply, whereas we have too much farm machinery that is power intensive, heavy, expensive and damaging to the land on which it works. The following facts illustrate the low quality of our farm technology. In 1986 we had 2,776,000 tractors, whereas the number of grain harvesters was 827,000 (a total of 3,603,000). At the same time we had a mere 1,528,000 tractor drivers and harvester operators, i.e. two machines for every driver. And here are figures for some areas of the Soviet Union: Latvia, for example, has 87 tractor drivers for every 100 tractors, Armenia—83, Estonia—79. In 1987, at the height of the harvesting season, 250,000 machines were idle.

The same way the desire to achieve high figures in the misinterpreted industrialisation and mechanisation of farming has led to a situation in which the number of lorries has come up to 1,917,000 with a mere 714,000 lorry drivers to drive them. A large proportion of lorries, just like tractors, harvesters and other machinery, is rusting unsheltered because many of them have been taken apart and used as spare parts.

"Industrialisation in animal breeding" is understood in this country as a concentration of livestock and fowl in gigantic complexes which, according to farming officials, are the only way to assure proper mechanisation in this branch. These complexes which have lately mushroomed all over the country are becoming a heavy burden not only on the nation's budget (the cost of construction of a stall for just one cow is somewhere around 4,000-4,500 roubles; expenditures on fodder delivery and the transportation of meat and milk to the consumer are also rising); but they are a burden on the environment as well. Dung-removal by water jet, and the gigantic scale on which this operation is carried out have greatly complicated the problem of utilisation of livestock waste. All told there are 500 million tons of manure disposed of every year, plus 25 million tons of fowl dung. Most of this waste is not utilised in agriculture, but is flushed into rivers and lakes, killing all life in them. Such practice poses a serious threat to human health. At the same time millions of tons of nutritious substances valuable for both the land and its crops get lost. It has been summed up that, for example, one pig complex for 54,000 head dumps an annual amount of waste which contains 860 tons of nitrogen and 550 tons of phosphorus.

The gigantic livestock complexes pollute the air in the same way. Every hour a pig complex for 108,000 head discharges into the atmosphere 159 kg of ammonium, 15 kg of hydrogen sulphide, 26 kg of dust, and 1.5 billion microorganisms. For large complexes, special sanitary-protective zones have been set up, as if they were regular industrial establishments. For example, fowl breeding factories for 600,000 chickens have a special protective zone of 2.5 km, a cattle farm for 210,000 head a 3 km zone, pig complexes for 108,000 and 216,000 head 5 and 10 km accordingly (although in reality pollution from the first type of pig complexes which is smaller in size, makes itself felt over a distance of up to 15 km). But cost-saving considerations dictate their own laws: anyway dairy maids cannot be bussed back and forth over a distance of 20 km several times a day, which is a costly proposition. So the farm attendants (and not those who thought of setting up these monstrosities) live close to the tremendous "swineville" and breathe all these noxious odours.

Gigantomania is typical of our animal husbandry not only in terms of increasing the production capacity of individual livestock breeding establishments, but also in terms of the total head of livestock. The production of milk and meat has been growing not by upgrading animal breeds, and not by improving the conditions of feed and upkeep, but by enlarging cattle herds. This can be judged from a comparative analysis of the development of dairy cattle breeding in the USSR and the USA.

Over the past three decades the milk cow population in the USSR has grown by 60 per cent to 42 million head in 1986, whereas in the United States it has shrunk by 54.6 per cent. Over the same period cow productivity per head in the USSR rose by 50 per cent to 2.700 kg of milk per cow, whereas in the United States it rose by 120 per cent. In other words the growth of milk production in the USSR is achieved by mainly extensive methods, whereas the Americans owe their achievements to intensive factors.

The low productivity of milk cows in the USSR comes from the insufficiency of fodder and its poor quality.

A large percentage of cows is sick and barren. And yet the main reason is the excessive milk cow population to the detriment of meat cattle breeding. The unjustified rapid growth of cow population generates complex economic, social and ecological problems. The construction of more and more cowsheds puts a great burden not only on agriculture, but indeed upon the entire national economy.

The upkeep of cowsheds, the excessive feed rations because of low nutritive value, the low productivity of animals because of disease, barrenness and poor breeds tend to increase the cost of milk and meat production. Since the government prices for milk and meat remain stable, the sale of these products at the state retail prices to the population inflicts an annual loss of 60 billion roubles. It has been calculated that the cow population could well be reduced by no less than 25 per cent without affecting the volume of production. This would make it possible to save tens of billions of roubles in investment and running expenses, release millions of workers for other jobs, make the cow population healthier, eliminate any shortage of fodder, end overgrazing on natural and cultivated grasslands and in this way save them from degradation and destruction. Thus by stopping the old practice of increasing the cow population, and indeed reducing it by at least by one million and by simultaneously reducing the construction of cowsheds would save the country about four billion roubles in capital investments, and 8 million cu m of ferro-concrete. It would also reduce the need for milk maids and other dairy workers by 40,000 (the shortage has been chronic).

An important source of higher animal productivity is to improve the quality of animal feed and to render it more balanced in terms of protein. It has been established that a one per cent shortage of proteins in the feed ration leads to an overexpenditure of feed per unit of milk and meat by 2 per cent. On average the amount of protein in the total mass of feed is 15-20 per cent below normal, which leads to an extra 30-40 per cent of feed consumed. One of the reasons for this state of affairs is the underestimation of the importance of natural glasslands, the diversion of livestock to farm field grazing and to feeding with concentrates. Over the past 15-20 years the consumption of grazing fodder has gone down, whereas the size of cattle herds has increased from 99 million to 121 million head. Over the same period the consumption of concentrated foods has risen by 43 per cent.

Significantly, over the same period the use of concentrated feeds in the United States has increased by a mere 30 per cent, and that of grazing fodder by 110 per cent. The intensive utilisation of grasslands for grazing enabled the Americans to obtain 11 million tons of cattle meat (slaughter weight). By comparison, in 1986 the USSR produced 7.7 million tons of meat, and that in spite of the fact that the United States has 115 million head of cattle, whereas the USSR has 122 million head of cattle.

Special mention should be made of the stepped-up production and supply of chemical additives for cattle feed. On the whole their supply increased (in terms of 100 per cent of nutrients) from 51,000 tons in 1970 to 1,069,000 tons in 1988, i. e. twenty times over. However, the results of their application in livestock breeding are rather dubious, and sometimes defeat the purpose for which they were used. One such example is the protein-vitamin concentrate (fodder yiest and paprin) obtained from paraffins. This concentrate is harmful not only for the animals, but also for people living close to the factories that produce them. Just to think how much money and effort are being wasted on the production of biochemical preparations from mineral raw materials (oil in this case), whereas the natural feed crops are clearly underestimated.

The situation is truly incongruous considering the fact that the USSR has 326 million hectares of grasslands and pastures: tremendous national wealth. It is true that most of these territories lie in drylands and deserts. However, even in these areas, with due attention given to watering, grass sowing, mulching and selective manuring they can serve as a reliable source of meat cattle husbandry.

* * *

Over the past several decades a great deal has been done in the USSR to introduce chemicalisation as a promising agricultural practice. As a result, we have been influenced by what we now think was an erroneous view that without application of artificial fertilizers and pesticides no land cultivation would be possible. For some reason we tended to forget that chemical fertilizers were first used a little over 100 years ago whereas land cultivation has existed for thousands of years.

The cultivation of wheat, barley, millet were known some 5,000 and even 8,000 years ago in ancient countries such as China, Egypt, also in some areas of what today is Turkmenia, also in areas around the Caspian Sea and in Transcaucasia. According to historians, the ancient Sumerians, who knew nothing about artificial fertilizers took in harvests of cereals much higher than we obtain by using chemicals.[1] Today crop-growing is fully geared to the use of chemicals. The worldwide production of chemical fertilizers (in terms of 100 per cent of nutrients) grew from 30 million tons in 1960 to 141 million tons in 1985, i. e. 4.7 times. In the USSR, over the same period the production of mineral fertilizers grew eleven times over, and that of nitric fertilizers sixteen times. The actual effect of this rapid growth of crop yield is fairly modest, but the damage the use of chemicals inflicts upon the natural environment is tremendous. It is the nitrates that mostly contaminate farm produce, especially vegetables. We need vegetables, and we cannot do without them. However, the cabbage, potatoes, radishes and cucumbers we eat as a rule contain nitrates. Upon reaching the alimentary canal they turn into nitrites which contaminate human organisms. This affects normal behaviourial patterns, reduces work capacity, causes dizziness and even loss of consciousness. If the doze of nitrite poisoning is high the result may even be fatal.

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[1] A. M. Rumyantsev, *The Primitive Mode of Production,* Moscow, Nauka Publishers, 1987, p. 206 (in Russian).

The action of these harmful salts has been studied sufficiently well. They suppress the breathing of cells, which leads to a sharp increase in the content of lactic acid, cholesterine, leucocites and reduces the amount of proteins. Interacting with haemoglobin, the nitrites produce methaemoglobin which blocks transportation of oxygen. As a result, the organism suffocates.

Man can easily sustain 150-200 mg of nitrates a day, 500 mg being his safety limit. If the amount of nitrates reaches 600 mg a day it may have toxic effects on a grown-up person. For a baby 10 mg is toxic. In actual fact we consume a lot more nitrates every day, because vegetables can accumulate these substances within a much wider range.

In natural conditions (in forests, for example) the content of nitrates in plants is fairly small, as they almost completely pass into organic compounds. If this plant grows on a patch of fertilized soil, the content of nitrates in it is 20 times as high as in the forest, and at times reaches even 40 times over. This is dangerous for human health.

Excessive chemicalisation of agriculture is a threat not only for people who directly consume its produce, but for all living nature. It has been established that in 57 per cent of cases the mass death of fish in reservoirs and other water bodies in the industrial areas of the United States and Western Europe is the result of the wash-off of chemical fertilizers from farm fields, and in 33 per cent of cases as the result of the pesticide poisoning of water.

Why do we rely so heavily on chemicalisation of agriculture in this country? We must admit that many of our planners, economic managers and agronomists regard the use of chemicals as some sort of panacea and believe that the growing consumption of mineral fertilizers and toxic chemicals will stimulate the growth of farm crops. In actual fact, this is nothing but a convenient, tried and tested method of concealing the facts of our economic mismanagement. Take, for instance, the growing of potatoes in this country. Traditionally Russia was rich in potatoes which was called "our second bread". But today, we shamefully admit that more than half the amount of potatoes consumed is brought to the Russian Federation from other republics, and even from abroad—Poland, the German Democratic Republic and even from far-off Cuba. Over the past quarter of this century, in spite of the marked increase in the introduction of fertilizers, the crop yield of potatoes in the Soviet Union is just about the same as before. As for their quality, all we can do is to sigh ruefully over the memory of sparkling white crumbly tubers. Incidentally, the absolute amount of potato crop harvested is quite sufficient to feed the entire population of the Soviet Union: 63 million tons, or 220 kg per capita (in 1988). However, more than half this amount never reaches the consumer and is lost rotting in vegetable depots. As a result, the per capita consumption of potatoes in the Soviet Union is a mere 98 kg. Those to blame for this are not only the irresponsible personnel of the vegetable depots and the poor conditions in which the potatoes are kept. It has long since been established that if potatoes or any other vegetables are loaded with nitrogen, they will soon rot no matter how ideal the conditions of their upkeep might be.

All this goes to show that the inordinate use of mineral fertilizers (primarily nitrous fertilizers) defeats the purpose for which they have been created in the first place: they kill harvests, deplete and worsen the quality of the food we eat.

Particularly dangerous is environmental contamination with pesticides. The situation gets more complicated as many of them disintegrate very slowly in natural conditions and therefore accumulate in the organisms of animals and humans, thus inflicting great damage upon their health. DDT is one such example. This very harmful chemical has long since been withdrawn from production and its use has been banned everywhere. Nevertheless, a whole million tons of this poison, out of 1.5 million tons which were used at one time or another, are still circling around the world. Regrettably, these "remnants" still make themselves felt quite noticeably in our country, too.

In spite of the official ban of DDT world-wide, its utilization in this country continues to this day, some reports say. It is true that DDT is no longer used in agriculture and has been restricted to the extermination of the encephalitis tick and some other insects. This is done with the permission of the Ministry for Public Health of the USSR which, once every five years, issues "temporary methodological instructions for the use of DDT and hexachloran" over the signature of the chief sanitary inspector of the USSR. The principal excuse for the use of DDT is "the absence at present of equally efficacious substitutes for DDT" in dealing with the encephalitis tick. Thus, poisonous chemicals are still sprayed over the taiga forests in Siberia, in areas with suspected encephalitis contamination near large construction sites with high concentrations of people. This is ostensibly done for the good of people and their health. Every year some 40-60 tons of DDT, 36 kg per hectare is dumped upon forests near the Sayano-Shushenskoye Hydro and the Maina Hydro. One can easily imagine how much DDT has already accumulated in the soil, and in the benthic deposits of rivers and lakes, also in the fish living in the River Yenisei. Requests for such toxic spraying by airplanes come from the Department of Water Reservoirs (which is part of the chief department for the exploitation of Yenisei water reservoirs) in the town of Maina which, with the consent of the local Soviet of people's deputies, and in accordance with a relevant resolution of the State Planning Committee of the RSFSR on combatting mosquittoes, concluded an agreement with an agency responsible for epidemics control. A similar situation exists at the Krasnoyarsk hydro-power station. Plans are afoot for using these toxic chemicals on the banks of the River Katun.

According to researchers at the Institute of Parasitology and Tropical Medicine (named after E. Martsinovski), this is a natural state of things, and that there has been too much commotion over the use of DDT.

Altogether more than 100,000 different pesticides are on sale on the world market, which leads to the destruction of at least one biological species every year.

It is not easy to forswear the use of pesticides everywhere, since they tend to raise the yield of farm crops and to protect them from pests and disease. However, we must not close our eyes to the harm they do. Therefore it is necessary to stop increasing their production, to stiffen control over their utilisation and later proceed to the reduction of their stockpiles. At present out of several hundred pesticides allowed for use in the USSR the laboratories at all government departments can effectively exercise supervision and control of a mere several dozen of them.

In the USSR the average annual per capita utilisation of pesticides was 1.0 kg in 1976-1980, 1.3 kg in 1981-1985, and is expected to rise to 1.7-2.7 kg in 1990. This rapid rise cannot be recognised as scientifically justified. The tendency which is taking shape elsewhere in the world is quite the opposite. In the USA, for example, the average annual per capita consumption of pesticides in 1980-1982 was 1.7 kg, whereas later, in 1984-1985, this quantity dropped to 1.6 kg.

The motives of this strategy are fairly convincing. It has been established in the USA that 80-90 per cent of fungicides, 60 per cent herbicides and 30 per cent insecticides are carcinogenic. It is also believed that between 10 per cent and 18 per cent of all deaths of people over 45 years of age are pesticide-induced. On their part Soviet researchers have established that the largest number of babies born with congenital defects in the USSR occur in Central Asia and Moldavia, i. e. regions where the use of pesticides is the highest of all.[1]

Pesticides are used in agriculture for raising the yield of farm crops. However, the expected results are illusory. Toxic chemicals suppress the biological activity of the soil, destroy the necessary microorganisms, and worms. They also reduce the natural fertility of the soil. In the centre of Russia every square metre of alluvial soil harboured 300 worms. Today this number has greatly gone down. The utilisation of herbicides, the destruction of the grass cover make the soil defenceless: it can no longer resist the action of wind and water and is doomed to erosion. Today hundreds of insect species are resistant to toxic chemicals. This fact induces the agronomists to look for new chemical substances, and this, in turn increases the so-called chemical pressure on the land. Lots of pollinants die, which leads to a sharp decline in farm crop yields. Among the crops affected are buckwheat and melons.

The land, nature and man need protection against this chemical onslaught. They need it today, now! What can we offer to protect them? The pressure of nitgrogenous fertilizers and toxic chemicals per unit of cultivated land is practically unrestricted by any official regulations. Such restrictions exist only for certain chemicals. These preparations are particularly dangerous when access to them is given to unskilled, unqualified, ecologically illiterate people who are not aware of the great hazards these chemicals have for nature and for their health. The Ministry for Public Health and its agencies do not provide necessary information, nor do they exercise adequate sanitary supervision and control. It often happens that upon expiry of their shelf life, chemicals are simply dumped into rivers. It is highly necessary to supervise the use of chemicals and see to it that those responsible for inflicting damage upon nature and people be brought to account.

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[1] A. Yablokov, *On the Underestimation of the Negative Effects of the Application of Pesticides*, Pushchino, 1988, p. 14 (in Russian).

The fact that the use of increasing quantities of mineral fertilizers does not guarantee higher crop yields can be judged from our agricultural practice. For example, the application of mineral fertilizers between 1970 and 1986 increased 150 per cent, that of pesticides 100 per cent, whereas the crop yield of cereals, cotton, sugar beets, potatoes, and sun-flower remains the same.

The following table shows the crop yields of cereals in the USSR and some other socialist countries achieved over the period between 1971 and 1987.

Table 12

The Yield of Cereal Crops (centners per hectare)

	1971-75	1980	1986	1987
USSR	14.7	14.9	18.0	18.3
Bulgaria	33.2	36.1	39.1	41.0
GDR	35.7	37.7	45.8	45.9
Hungary	35.0	47.3	48.1	48.6
Czechoslovakia	33.9	40.1	42.0	45.9
China	—	28.4	37.7	38.0

As you see, the Soviet Union is far behind the other socialist countries in crop yields.

Soil amelioration has also failed to set things right. The very term amelioration comes from the Latin word *melioratio*, which means improvement. However, our soil amelioration practice does not match the meaning of this term.

As they launched gigantic programmes over the two decades, 1966-1986, amelioration and water management authorities made generous promises. At numerous conferences, in countless dissertations, in newspapers, magazines and monographs, also from the rostrums of party and government forums the executives of these offices and centres gave their assurances that the development of soil amelioration would sharply increase the output of farm produce, would make such production more stable and would guarantee bumper harvests. On security of these magniloquent promises the ministry obtained whopping funds from the state budget. From 1971 to 1988 alone Minvodkhoz expended 131 billion roubles of capital investment, or 28 per cent of the entire sum invested in agriculture.

What did we gain from all these extravagant expenses? Nothing. The whole thing was one huge financial loss, not counting the vast amount of unproductive hydro-engineering work done. The entire multifarious activity for soil amelioration, which included some forty different types of work was eventually reduced to either irrigation or drainage. Over the said period 118 major water reservoirs, 5,000 pumping stations, 1.5 million different hydro-engineering installations were built. The total length of the irrigation network in the Soviet Union reached 700,000 km. Incidentally, this is 50 per cent more than the total length of motorways with a hard road surface. A total of 11.7 million hectares of irrigated and 11.5 million hectares of drained land were opened to agriculture. It must be noted that over the same period the poor quality of work made 2.9 million hectares of irrigated and 4.3 million hectares of drained land, or 25 per cent and 37 per cent respectively to the total of the newly ameliorated land, uncultivable. As you see, the situation is clearly abnormal. Speaking at the all-Union economic conference on the problems of the agro-industrial complex, in March 1984, Mikhail Gorbachev said: "Over the past several years the funds have been mainly directed towards new soil melioration projects. At the same time the amount of money and resources earmarked for the reconstruction and maintenance of the existing systems are clearly insufficient.

"This situation is largely influenced by the parochialism of the ministry for land amelioration and water management. The various organisations of this ministry willingly take up major costly projects but often slip away from their reconstruction."

The returns on the funds expended on land amelioration are inexcusably low owing largely to the poor quality of water handling work, to the contempt for many cheap but at the same time highly effective methods of complex amelioration, such as afforestation, fight against soil erosion, upgrading of meadows and grasslands, lime pretreatment of acid soils, gypsuming of solonetz (alcali soils), sideration of fallow land, stake on expanding irrigated and drained land. Suffice it to say that 2/3 of irrigated land still do not yield the harvests planned for it.

Irrigated farming is based on old, wasteful and backward methods. Filtration and evaporation alone from main trunk and diversion canals lose up to 40 per cent of the water in-take. The quantity of water used for irrigation exceeds the optimal level by 100 and even 200 per cent.

Because of such excessive watering and the insufficiency of the drainage and collector systems (or their absence), large areas get salinated, partially flooded, lose their fertility and can no longer be used for farming. To compensate these losses the Minvodkhoz takes control over more and more land (as a rule with poor soil).

In his speech at Tselinograd in September 1985 Gorbachev pointed out that "the primary task is not to expand the area of ameliorated land, but to make sure that they are used effectively. Crop harvests in such fields do not match the expenditures we agreed to make, nor do they match the actual possibility of land improvement. ...It is necessary to show greater concern for taking urgent measures to drastically improve the state of ameliorated land. It is here that capital investments should be channelled in the first place."

However, the ministry continues to press ahead for more extensive irrigation and amelioration, as the most costly operations[1], very much to the detriment of less costly but more important and effective amelioration work.

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[1] Per hectare investment in ameliorated land grew from 3,700 roubles in 1971-1975 to 6,556 roubles in 1981-1985.

Over the eleventh five-year plan period alone, 3.3 million hectares of irrigated and 3.5 million hectares of reclaimed land were opened up to farming. Over the same period the area of watered pastures was 25 per cent smaller compared to the area opened to grazing in the previous period, whereas the volume of work done to improve the condition of the soil shrank by 28 per cent.

The unjustified expansion of irrigated areas, and the backward and water-wasting techniques of irrigation have led not only to extensive losses of precious soil, but have also created a shortage of water resources in the southern areas of the country. To make up for this shortage, Minvodkhoz has feverishly proceeded to work out senseless and wasteful projects of diverting the flow of northern rivers. Instead of stopping the prodigal waste of water resources and introducing some kind of order into water management, the Minvodkhoz management and its design agencies came up with "the project of the century". For many years they worked on that project whereby a part of the flow of the Siberian rivers be diverted into Soviet Central Asia and Kazakhstan, and some northern rivers over the southern slope of the European part of the country. Characteristically, even the head water managing R&D organisation in the country—the Soyuzgiprovodkhoz—was in 1978 renamed the All-Union State Head R&D Institute for the Diversion and Distribution of Waters of the Northern and Siberian Rivers.

The development of these cyclopic projects was the main job of the Ministry and its R&D organisations. According to Minvodkhoz itself, the drafting of these projects used up 83.8 million roubles in direct financing from the State Bank of the USSR. Realisation of these projects would cost the nation hundreds of billions of roubles, and would inflict tremendous damage upon its economy, ecology and its culture.

The decision of the Central Committee of the CPSU and the Council of Ministers of the USSR issued on August 14, 1986 on stopping the project prevented commission of this crime against nature. However, Minvodkhoz and its bureaucratic apparatus did not lay down arms. All they did was to change their tactics. Having 50 billion roubles at its disposal to be invested over the current five-year plan period, plus a tremendous amount of machinery and other production facilities, the ministry is stepping up the construction of economically unsound and ecologically dangerous canals between Danube and Dnieper, the Volga and the Don, the Volga and Chograi, the Ob and Karasuk, etc.

Plans are afoot for increasing water consumption by 21 per cent in agriculture and by 37 per cent in industry by the year 2000. The concept that there is a growing water shortage is false. Yet it is being assiduously pushed, and proposals have been made to go back to the question of traditional redistribution of water resources, which fundamentally contradicts the strategic course of the Soviet state to protect the environment, to conserve natural resources, and to further intensify production in every way.

* * *

Over the past two decades, in spite of the fact that materially and technologically Soviet collective and state farms are much better equipped today than before, the growth rates of farm production has been going down practically every year, whereas production costs have gone up sharply which is borne out by the following data:

Table 13

The Average Annual Rate of Growth of Overall Farm Produce (per cent)

	1966-70	1971-75	1976-80	1981-85	1986-88
Plant-growing produce	4.1	1.7	1.8	0.5	0.4
Animal husbandry	3.8	3.2	1.5	1.5	3.0

Table 14

Cost of Production of One Ton of Farm Produce on Collective and State Farms of the USSR

	1970	1975	1980	1985	1986	1987	1987 in % to 1970
Grain	51	80	80	103	100	101	198
Raw cotton	397	432	487	604	608	609	153
Sugar beets	23	30	32	37	38	35	152
Sunflower seeds	58	71	93	110	111	107	184
Potatoes	67	86	129	155	139	154	230
Field vegetables	88	103	112	132	134	138	157
Weight accretion in young stock and weight accretion from fattening:							
cattle	1,212	1,704	2,278	2,738	2,619	2,740	226
pigs	1,161	1,513	1,909	2,193	2,060	2,039	176
sheep	766	1,050	1,366	1,894	1,794	1,824	238
Milk	182	229	297	358	354	340	187
Eggs (one thou. pcs.)	67	63	65	65	63	62	92
Wool (in weight)	3,889	5,573	7,470	9,732	9,445	9,642	248

The attempt to achieve higher production and make it economically more effective by purely technocratic means, without taking into consideration the natural resources potential of the country, has not only failed to produce the desired results but has effectively aggravated the problem. The economic problems have also been added by ecological ones.

Monitoring of the environmental factor and prognostication of all possible ecological disruptions directly affecting agriculture are of particular importance, since this sector is closely linked with animate and inanimate natural features (plants, microflora, soil, moisture, temperature, etc.). Farm produce are created not only through the utilisation of material and labour factors, but also by making use of natural and biological resources and processes. It would be impossible to increase the effectiveness of farm production and returns on investment without conserving and improving the principal components of the natural environment in both natural ecological systems and in manmade agrobiological systems, with natural biogeocenoses in the first case, and cultured agrobiocenoses in the second. Taken together they form the landscape, that is, a higher natural-anthropogenic system that must be both protected and used rationally.

In economic geography landscape potential is a complex description of a certain area arising from its natural structure. The term landscape potential includes such properties as possible anthropogenic pressure, stable resistance to such pressure, capability for self-regulation, self-purification and self-restoration.

As society's production forces develop, the natural geobiocenoses are replaced by cultured agrobiocenoses. Suffice it to say that 57 per cent of the territory of the Ukrainian and Moldavian SSR are taken up by agrobiocenoses, not counting the natural grasslands and pastures which, incidentally, have also come under considerable anthropogenic pressure. About as much territory is taken up with agrobiocenoses in the Central Black Earth Region of the Russian Federation, in the Volga area and in the Baltic has similarly been affected.

Cultured agrobiocenoses have higher biological productivity and must therefore be given special attention in our efforts to protect the natural environment. Actually the whole of Soviet territory has in one way or another been affected by anthropogenic changes. Most of the natural ecosystems have been almost completely transformed and have been replaced by anthropogenic systems.

With most of the steppelands and forest-steppes ploughed up, with the forests being cut intensively, and with the constant disruption of crop-rotation, the plant and animal world is becoming more depleted, and the natural processes involving circulation of matter are getting weaker. The soils of these ecosystems are losing their reserve of biogens, and notably humus (the main component that gives soil fertility) accumulated over many centuries. The loss of humus is great in the intensively worked black earth which has been hit by erosion.

In heavily eroded black earth areas, which in some regions constitute somewhere between 20 and 50 and even more per cent of the total arable land areas, the quantity of humus has dropped by about 40 per cent. In some regions the loss of humus in the soil is particularly high. In Moldavia, in the southern Ukraine, in vast areas around the Volga, also in a number of areas of the black earth zone in Central Russia, the content of humus in the soil has gone down 50, 70 and even more per cent. Wind erosion and water erosion, also the utilisation of heavy machinery on the fields, which weakens and disrupts the structure of the soil, the suppression of microflora as the result of intensive chemicalisation have reduced the content of not only humus, but indeed the total mass of organic substance, the basis of soil fertility. Studies showed that the content of humus (in percentage to the weight of the soil) in the black-earth of the Stone Steppe in the Voronezh Region is 11 per cent in virgin, unploughed areas and in the fields protected by afforestation belts it is 9.1 per cent while in the open steppes the humus content is a mere 6 per cent.

It is practically impossible to make up for these losses without introducing large volumes of organic fertilizers and without fundamentally improving the agricultural techniques. The attempts to make up for the loss of the organic components of the soil by applying artificial fertilizers have so far failed to produce the expected results. As we noted earlier on, the consumption of nitric fertilizers increased 2.6 times between 1970 and 1986, whereas the crop yield of the main agricultural crops was roughly the same, and in some cases even lower.

The agrobiocenoses which are characterised by removal of substances, and notably the biogens, in the form of farm produce gradually cease to be autonomous and self-reproducing. To retain their productivity, let alone raising it, a system of agrotechnical ecologically sound measures would have to be carried out.

To raise the productivity of agrobiocenoses requires:

strict observance of scientifically grounded crop rotations, introduction of the required doses of organic and mineral fertilizers, the application of ecologically sound methods of soil cultivation (boardless ploughing, combining of different operations, utilisation of machines that spare the structure of the soil, etc.). It is also necessary to carry out water, forest and chemical amelioration, to preclude disruption of the hydrological regime of the soils, their pollution with waste water and the atmosphere, to improve the quality of selectionist work, to introduce crop-rotation, to plant afforestation belts around farm fields.

There has been a lot said over the past several years about dwindling ploughland (per capita), this being regarded as the principal cause for the unsatisfactory state of agriculture. Actually such reduction is taking place. In 1960 there was 1.02 hectares of ploughland per capita in the USSR whereas today its size has shrunk down to 0.80 hectares. However, this process is taking place in many other countries, owing to continuing population growth and the limited size of arable land. It is true that farm land must be protected against industrial expansion and even more so against depletion and mismanagement. At the same time efforts must be made to restore its fertility. A comparison of the arable land in the Soviet Union and in other countries shows that land shrinkage is not the main reason for the low productivity of our agriculture.

Table 15

Crop Area and Per Capita Production of Grain in Some Countries

Countries	Crop area (hectares)	Grain production (kg)
USSR	0.76	661
USA	0.61	1,312
Canada	0.81	1,986
France	0.31	942
Hungary	0.45	1,366
Sweden	0.36	680
Finland	0.50	770

The above figures show that, with the largest (except for Canada) crop area in the world, the Soviet Union has the lowest per capita production of grain. This unenviable situation is the result of the erroneous practice of our planners and economic managers geared to the technocratic concept of industrialisation of agriculture and to the extensive growth of production by expanding ploughland, by saturating our agriculture with powerful machinery and chemicals, by expanding water facilities.

The traditional material-intensive technologies are clearly leading our agriculture into a dead end. The application of so-called intensive technologies sharply increase the aggregate expenditure of energy. Agriculture which has always been a major supplier of energy through the accumulation of solar energy in the process of photosynthesis has, over the past several decades, become a voracious consumer of energy. For instance, in the United States 9 calories of non-renewable energy from fossil fuel are expended per one food calory. Of course, field of wheat cultivated in accordance with a material-intensive technology yields a higher harvest, although at the same time it raises the expenses on machinery, land cultivation, fertilizers and pesticides. As a result, toxic chemicals get into the natural environment, into the products and consequently, into the organism of man.

In these conditions more and more significance is attached to the biological factors that stimulate crop yields and animal productivity. These factors are based on the achievements of modern genetics, plant selection, and on agricultural practices, which is the subject of the next chapter.

Chapter Three

RATIONAL UTILISATION OF THE ACHIEVEMENTS OF SCIENCE AND TECHNOLOGY—THE WAY TO SURVIVAL

> Man's knowledge of the geological history of the biosphere will open vast vistas to his own future, if he understands this fact and does not turn his intellect and his labours to self-destruction.
>
> *Vladimir Vernadski*

In the powerful stream of scientific literature, in newspaper articles, in countless lectures, in political declarations and in documentary films, on radio and TV, at various symposiums, in public and private debates, we often see by now familiar word combination—scientific and technical progress. It is used with regard to production and consumption, to work and leisure, in fact in relation to all earthly affairs, and even outer space. When they speak about such "progress", most people don't even think what it really means. Although there is something to think about, too. And really, why "scientific" and why "technical"? And is scientific always progressive? And is technically perfect always scientific? What kind of progress is meant here? And what is "progress" anyway? This is how encyclopaedic dictionaries answer this question. The word "progress" (*progressus* in Latin) means the development of all that is new, advanced, it also means a movement towards a better state of things, a transition to a higher level of development. But if we give it enough thought, this term does not explain anything. One of the definitions is "the development of the new". But does this mean that everything that is new is better, and more advanced than what is traditional? And what is "advanced"? Advanced in relation to what? And what is a more advanced level? In relation to what is this level more advanced, and how is this stage to be measured?

These questions are not scholastic as they may seem at first glance. On the correct answers to them depends the success of any concrete activity, including that of environmental protection.

I. The Concept and Essence of Scientific and Technical Progress

The acceleration of scientific and technical progress in the modern economic policy of the USSR is regarded as central to making social production more effective, also to the solution of social problems facing the country. In June, 1985, Mikhail Gorbachev said: "We will have to technologically reshape our economy and qualitatively transform society's material and technical basis. This work must be launched without delay: it is the responsibility of the entire Communist Party and all the people. It must be accomplished in the shortest possible time, which will make the nation a leader in terms of labour productivity and economic efficiency. The only way this can be done is by intensifying production on the basis of the latest achievements of science and technology."[1]

Thus, the scientific and technical progress is that one and only foundation on which the cardinal problems of economic and social development can be resolved. Among these are such key problems as the growth of labour productivity, intensification of production, rational use of natural resources and environmental protection. It would be impossible to improve the living standard of society without first resolving these closely interconnected tasks. Let's take a look and see how these tasks are being resolved today, and how they can best be resolved in the future, considering the prospects for the development of Soviet society until the end of this century.

The modern practice of economic analysis shows that these indicators are, as a rule, viewed isolatedly without any connection between them. This approach makes it easier to create the impression that science and technol-

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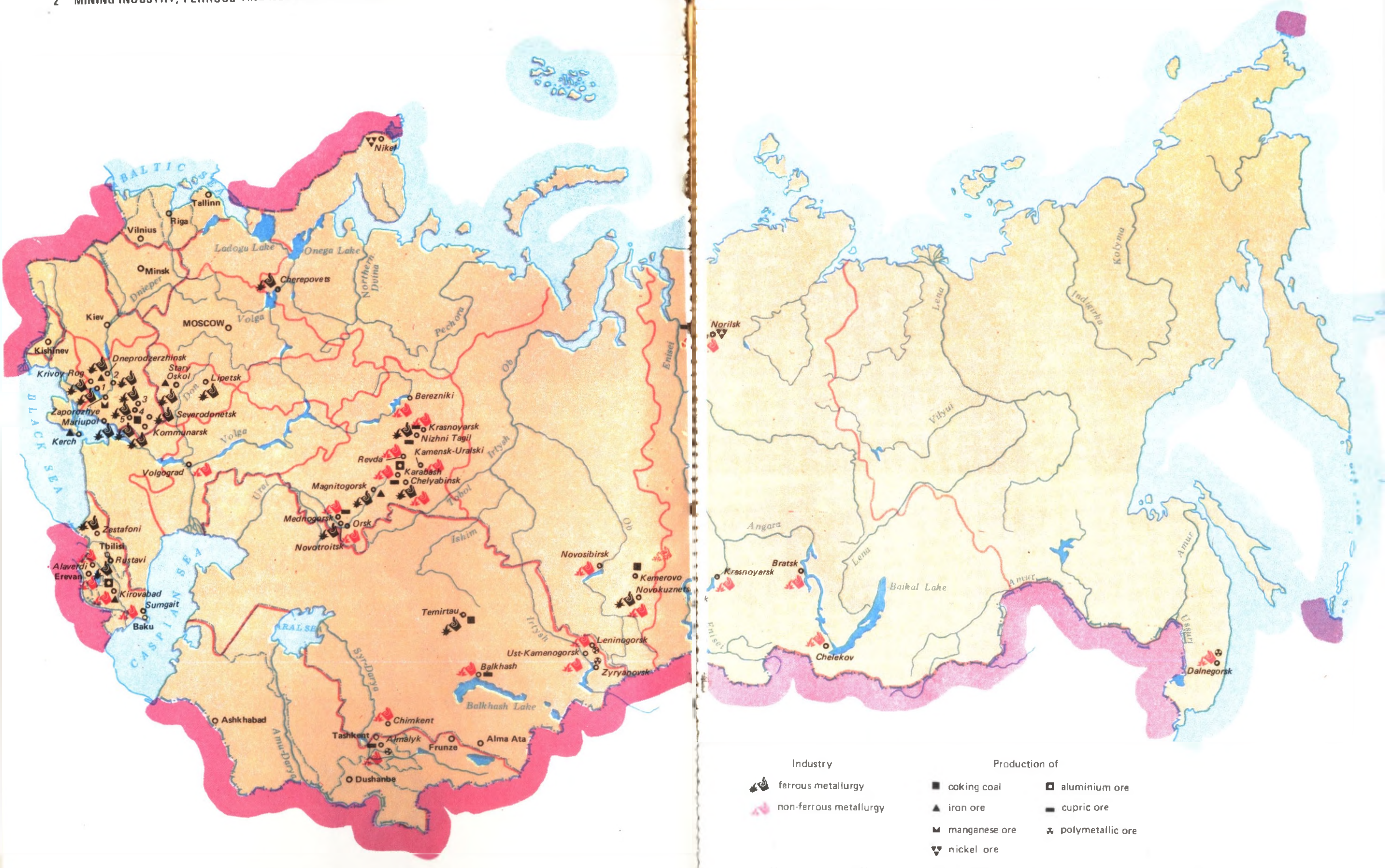
[1] Mikhail Gorbachev, "The Key Issue of the Party's Economic Policy", *Selected Speeches and Articles*, Progress Publishers, Moscow, 1987, p. 101.

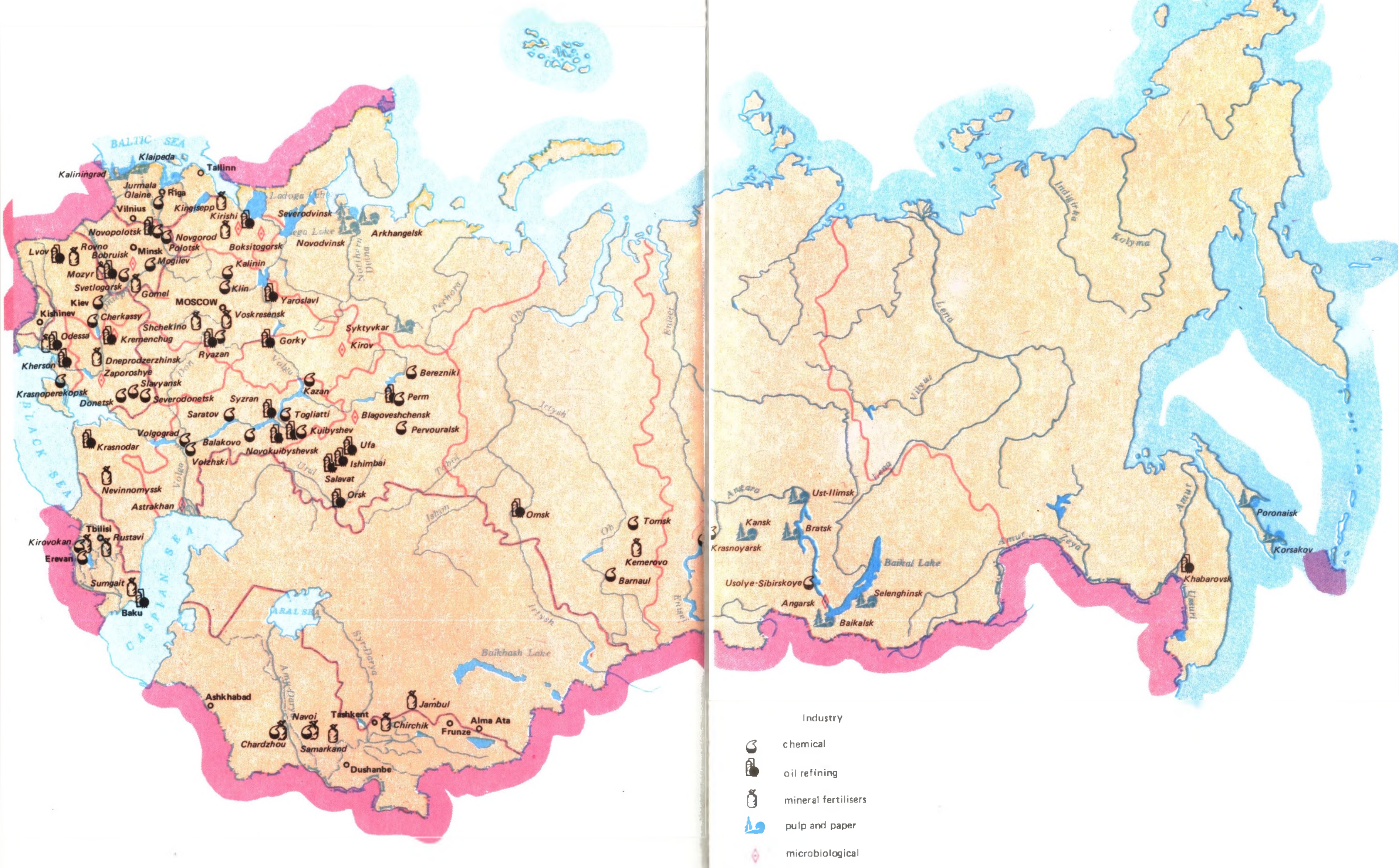
Чистый
город —
нашим детям!
КАК ТАК?!

People are becoming more and more ecologically aware. An ecological rally in Kemerovo, 1988

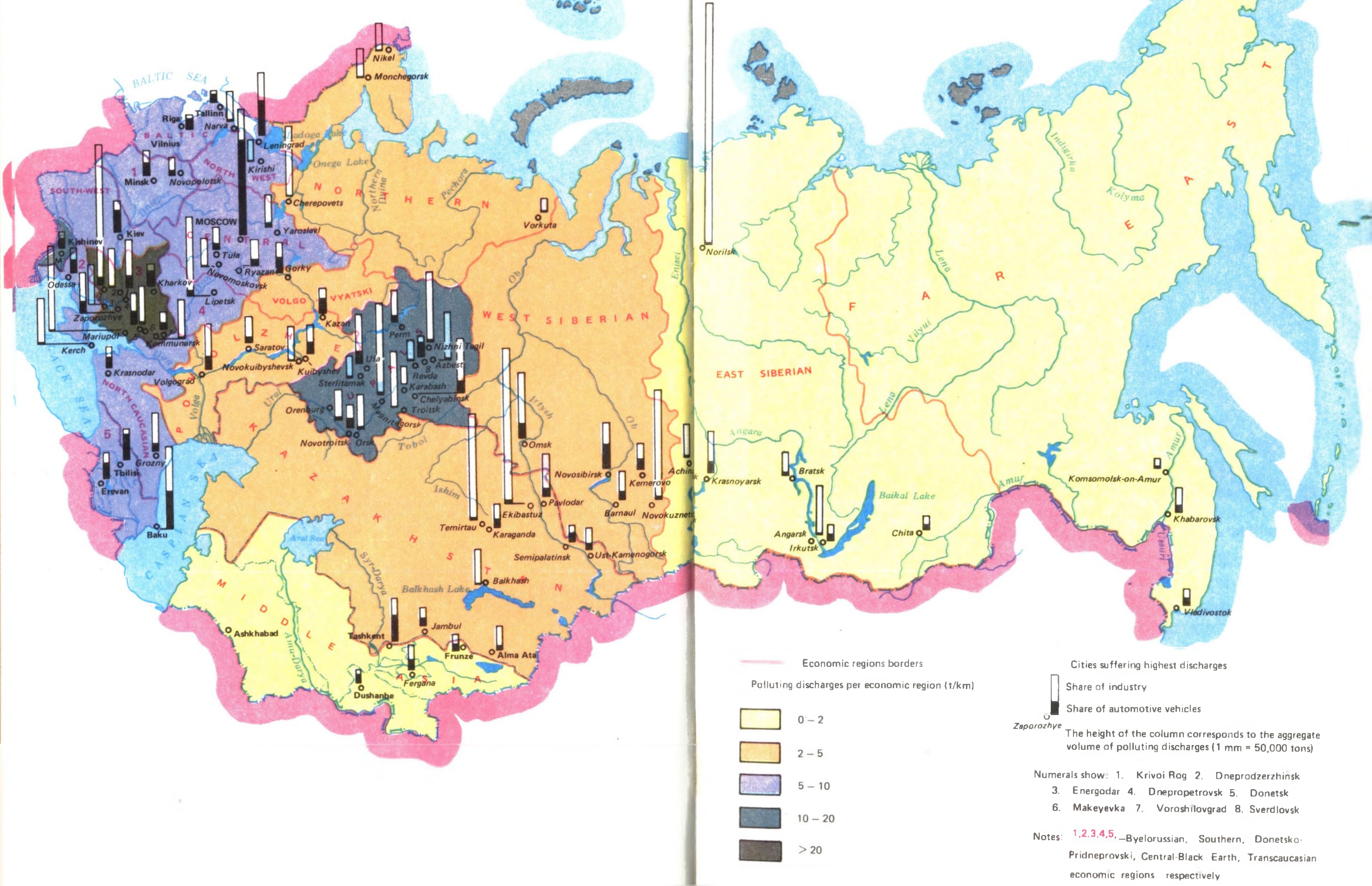


Numerals show: 1. Nikopol 2. Dnepropetrovsk 3. Kramatorsk 4. Konstantinovka 5. Donetsk-Makeyevka

3 CHEMICAL, PULP AND PAPER, AND MICROBIOLOGICAL INDUSTRIES



POLLUTING EMISSIONS OVER THE TERRITORY OF THE USSR



Economic regions borders

Polluting discharges per economic region (t/km)

🟨	0 – 2
🟧	2 – 5
🟪	5 – 10
🟦	10 – 20
⬛	> 20

Cities suffering highest discharges

Share of industry

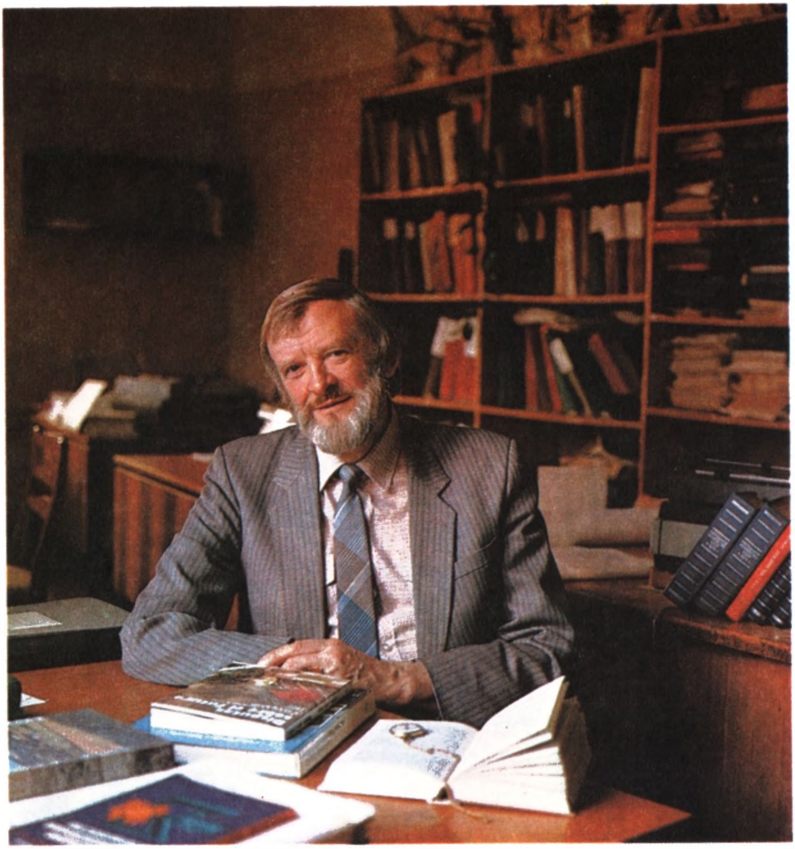
Share of automotive vehicles

Zaporozhye

The height of the column corresponds to the aggregate volume of polluting discharges (1 mm = 50,000 tons)

Numerals show: 1. Krivoi Rog 2. Dneprodzerzhinsk 3. Energodar 4. Dnepropetrovsk 5. Donetsk 6. Makeyevka 7. Voroshilovgrad 8. Sverdlovsk

Notes: 1,2,3,4,5,—Byelorussian, Southern, Donetsko-Pridneprovski, Central-Black Earth, Transcaucasian economic regions respectively



The author

Table 16

Industrial Growth in the USSR (per cent)

Indicators	1970	1980	1988
Gross industrial output	100	178	241
Industrial personnel	100	117	120
including engineers and technicians	100	139	151
Labour productivity	100	156	192

ogy are making rapid progress. Suffice it to say that over the said period the output of manufactured goods increased by 140 per cent. This sure is a mark of rapid progress!

At the same time labour productivity rose by 92 per cent, which also seems to be an important achievement. However, if you take a closer look you will see that the growth of industrial production was still largely achieved by increasing the number of industrial personnel, which can be judged from the above table. The total number of industrial workers grew by 20 per cent, whereas the number of engineering personnel increased by even 50 per cent. Doesn't this show the extensive growth of this sector of the economy and at the same time the lack of effective scientific and technical progress? All the advanced capitalist countries have over many years achieved their industrial growth without increasing and even with decreasing the number of employees. In the United States, for example, the number of industrial employees dropped by 15 per cent over the period between 1973 and 1983. With 60 per cent more industrial workers than in the United States, the Soviet Union produces 80 per cent of the industrial goods produced in the USA. In agriculture this gap is much wider.

Our statistics shows tremendous agility when it comes to demonstrating our "outstanding" achievements. The statistical yearbook *The Soviet National Economy* contains data such as this: industrial output in 1986 exceeded that of 1913 by 205 times, and capital investment by 154 times over, labour productivity is 64 times as great. No less impressive, in the view of our statisticians, must also be the following data. Our country produced 85,000 tons of oil in one day in 1940, whereas in 1986 this figure had increased to 1,690,000 tons. Similarly the extraction of natural gas rose from 8.8 million cu m to 1.951 million cu m, and television sets from one to 27,000. Of course, all these figures are nothing short of stunning. The daily production of oil rose 20 times over that of pre-war output, the output of gas 222 times, and television sets 27,000 times over. The yearbook also contains these figures: the average monthly wages of industrial and office workers was 33 roubles in 1940, whereas in 1986 the wages had gone up six times over, to 196 roubles a month.

Let's ask our enraptured statisticians: what is the aim of such reports? What are they expected to prove? In the modern world it is totally impermissible to judge scientific and technical progress only by the gross industrial and agricultural product, even when it concerns so-called "progressive" types of goods. To show that such judgement is one-sided, that it does not disclose the essence of the processes taking place in science and technology, we shall compare the dynamics of production, in the USSR and the USA, of metal-cutting machine-tools with numerical programmed control which are to this day regarded as the most important factor of growth of labour productivity and as the hallmark of the quality of products manufactured with their help. In 1980 the USSR and the USA produced roughly the same number of such machine tools: 8,900 each. Later, however, this correlation changed sharply. In 1986, the Americans reduced their production down to 4,600, whereas here in the Soviet Union their number shot up to 20,300 a year. Significantly, the correlation between labour productivity in the two countries has not changed: in the Soviet Union it is still 55 per cent of the American level. How can this situation which is highly unfavourable for this country be explained? There are several reasons for it. But from the point of view of scientific and technical progress the fact is that in the United States the manufacture of machine-tools, over the said period, moved to highly efficient manufacturing centres with flexible (adjustable) technology. We are only making the very first steps in this direction. As for conventional machine-tools, we have plenty of them. On average we have three such machines per one operator. What a colossal amount of idle capital in the form of lost labour and materials!

You may wonder if there is any direct relationship between such technical innovations, on the one hand, and nature protection, on the other? Such relationship (and a very close, indeed) does exist. Since the Soviet Union produces 340 per cent more machine-tools than the United States, it also expends correspondingly more metal for their production. Considering the fact that the production of our machine-tools is much more metal-intensive, our machine-tool industry requires about 500 per cent more metal than do the Americans. Therefore it is necessary to have greater steel smelting capacities and to extract more iron ore. It is easy to understand how much the natural environment should suffer from all this. As we showed earlier in this account, the metal smelting and mining industries are among the biggest sources of ecological destruction and pollution, affecting not only the land, but also water and air over large regions of the country.

However, the above considerations are related not only to the machine-tool industry. A similar situation obtains in some other branches of mechanical engineering. As we said earlier on, the Soviet Union manufactures five times as many tractors as the United States. In 1986 their total number was 595,000. Of this number 395,000 were supplied for agriculture, 39,000 were exported and the remaining tractors were used in other fields.

First, the national economy simply does not need so many tractors. For instance, many farming enterprises have 70, and even fewer, tractor drivers per 100 machines. This means that the tractors very often stay idle or are taken apart for spare parts which have for decades been in short supply. Of course to get spare parts for this legion of tractors, which besides are not reliable in operation, is no easy matter. Another thing that merits attention is the fact that Soviet tractors are very heavy. Here is a concrete example to illustrate my point. One of the biggest ministries of the country — the Ministry for Farm Engineering — undertook the production of another jumbo, the T-330 tractor, for which purpose a giant plant has been built in the city of Cheboksary. The new tractor has been widely advertised as a great achievement of scientific and technical progress, and it raised great hopes. But how has it worked in practice? Over the very first few months of their exploitation the new machines showed some serious defects in their design and manufacture. For example, its air-cooled engine is highly undependable. In addition to that the T-330 is much too heavy. According to the users, a bulldozer built on the basis of the Cheboksary tractor, and having the same power capacity, weighs 18 tons more than its analogue manufactured by the Komatsi Company in Japan. Therefore tens of "horse-powers" of its diesel engine have to work in order to merely move this excessive weight. Many of its units and parts have proved faulty. As a result, some of these machines could not even leave the factory grounds under their own power.

All these facts failed to arouse the concern of the manufacturers who apparently thought that all these faults and defects would eventually be straightened out. The only thing we have achieved so far is that the tractor plant has become the biggest industrial enterprise in Chuvashia and the best equipped of its kind in the industry. For example, it has more than 500 machine-tools with numerical programmed control most of which are of foreign make. In addition to that the tractor manufacturing plant has a large of research and development staff.

The machine still has lots of faults that have not been corrected. And yet the ministry and the tractor manufacturing plant are all set for the production of a new heavy-duty tractor — T-500 — which, alongside other models, is expected to replace the T-330 in 1991.

What is the situation now? Let's not jump to conclusions. But judging from the test certificates, the new tractor tends to break down just as often as its predecessor. The only good thing about the new tractor is its West German manufactured engine that nobody has so far complained about. Comparative tests showed that T-500 is not as good as the Caterpillar: its tractive power is lower, it consumes more fuel and is not as reliable or as comfortable in use.

The list of machines which our industry manufactures in thousands, and even millions of units — more for the purpose of realising departmental, bureaucratic ambitions with no consideration given to the real demand for them — can be stretched indefinitely. We shall not cite any more examples at this point, and shall, instead, retrace the chain of technological links which are at the bottom of the shortage of resources in spite of their continual growth.

It is easy to see what tremendous amount of electric power is needed for manufacturing all these unwanted machine-tools and tractors. And that besides the tremendous amounts of castings and rolled metal produced in foundries, slabbing and blooming mills. And again we need more electric power in order to make all this equipment work. Blast furnaces and electric furnaces that smelt all this metal also need electricity. The extraction of iron ore, its dressing and delivery to these users also need electric power. This is how a shortage of electric power comes about as the result of just one production cycle — one out of a great many in our national economy.

This is where another powerful government department — Minenergo — steps in to resolve a practically unresolvable task: liquidation of the shortage of electric power by way of its forced growth through the construction of gigantic electric power stations, an old tried-and-true method which destroys and contaminates the natural environment, changes the face of the earth and kills all living things on it.

Of course, the life of modern society is unthinkable without electric power. Therefore we are talking not about freezing the growth of electric power production, but about the need to pinpoint real, rational requirements for electric power, about how to generate it without hurting ecological interests. A programme for providing the Soviet Union with electric power and other energy sources should be elaborated not by merely integrating the claims of government departments for it in their desire to serve their bureaucratic plans for maximising the output of often unnecessary products, but by fundamentally restructuring the entire national economy.

The national economy has to be reoriented away from the production of primarily intermediate products of social labour toward the production of final products, thus meeting the needs of the consumer rather than those of government departments.

This calls for changing the structure of utilisation of the national income. What we need is to reduce the share of accumulation, and not to increase it. We must clearly understand that the production of the means of production is not the aim in itself. The volume and structure of the national income must be geared to the satisfaction of public needs.

The production of tools and objects of labour (i. e. materials) is to be regarded as a means whereby this goal can be achieved. Therefore these components of the production process are required in precisely the amounts necessary to assure their production at full capacity. Our planning practice has been hallowed by the slogan: "Everything for man, everything for the benefit of man." But in reality the interests of man are ignored.

How does this work out in practice? In the first place there is too much construction going on, whereas the old production assets, resource-intensive and at the same time pollution-intensive technologies are still used on a large scale. Here is an example. We have twice as many work places per worker employed in the national economy as does the United States. With more work shifts introduced at our factories and plants, the number of work places is increased still more, whereas government ministries and their departments are creating new jobs, knowing full well that there will be no workers to fill them. For instance, at the plants and factories under Minstankoprom (Ministry of Machine-Tool Manufacturing Industry), over the period from 1975 to 1985, the volume of production doubled, whereas the number of unfilled vacancies increased five times.

It must be borne in mind that our work places are among the cheapest and technically the least equipped among the industrial nations. And since the accumulation fund is growing in terms of absolute figures, new work places are mushrooming. Suffice it to say that two thirds of engineering products are delivered to new factories and only one third of their number is used for replacing the old machinery and equipment. Moreover, it is hard to tell how much precious working time goes to waste, because our statistics tend to embellish the facts. All we can add here is that 70 per cent of the monthly quota are usually produced over the last ten days of each month, and more than half of the yearly quota over the last three months of each year.

This crying economic disproportion is exacerbated by the fact that more and more jobs are moving into industries that directly feed off natural resources. If we compare the structure of the production assets of different countries, we shall see that back in the early 1960s the proportion of assets in the extracting industry in the Soviet Union was larger than in the countries of the West, but smaller than in the former colonies. In the mid-1980s we "outpaced" in this respect the least developed countries with their predominantly raw material economies.

In the Soviet Union the fastest growing are the industries engaged in the extraction of mineral wealth. In 1928, their proportion in total production was 40 per cent, in 1949—60 per cent, and in 1985—75 per cent. If this tendency continues until the end of this century, then, in the words of one economist, "the Soviet Union may quite possibly become a society of ore miners".

The main reason for the growing shortage of electric power in the country is the predominance of capital goods industries and the continued use of old resource-intensive technologies in these industries. To bear out this conclusion we shall again turn to comparable data on the USSR and the USA. Defending their plans to increase the production of electric power at any price, including the destruction of the natural environment, our power authorities and planners come up with the argument that we are lagging behind the Americans in power production. This is correct. The USSR generates 1.7 trillion kwh of electric power, as compared to 2.7 trillion kwh in the United States. However, our power authorities and planners for some reason ignore one important point: the fundamental differences in the distribution of electric power in these two countries. Of the total amount generated in the United States, 32 per cent is used in industry, as against the 58 per cent in the USSR. This alone would give us a clue to the source of the electric power shortage in the Soviet Union. To make our line of reasoning more convincing here are some figures on the absolute consumption of electric power: Soviet industry consumes an annual total of 950 billion kwh as against 870 billion kwh in the United States. But the United States produces 20 per cent more manufactured goods than the Soviet Union. As for the expenditure of electric power in agriculture, it is 3.5 times as great as that in the United States.[1]

Let's take a brief look at some possible ways of ecologisation of production in some branches of industry.

It has been proved on the basis of Soviet and foreign experience that such ecologisation is not only very encouraging but is indeed quite feasible if viewed over the period before the end of this century.

2. Ecologisation of Industrial Production

One of the promising areas of development of *power engineering* is to use renewable sources of energy. These sources, in my view, are mistakenly called "non-traditional". Speaking of the energy of the sun and wind,

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[1] Moreover, we use only one eighth the electricity for municipal and domestic needs as in the United States. In fact we lose 30 per cent more electricity in the power networks than we actually use.

I think that these are precisely the sources that are very traditional for they are almost as old as the history of human civilisation.

Man has always warmed himself in the sunshine, except for the winter season in the northern latitudes of our planet. He dries his clothes, his shoes and the feed for his cattle in the sun, and there in the sunshine he cures his fish and meat. Agricultural crops still depend on the accumulation of solar energy. As for the energy of wind and water, back in 1850 this constituted 90 per cent of all the energy consumed in those days, with coal, oil and gas constituting a mere 10 per cent. By 1975 the proportion of water and wind in the energy balance was reduced to 5 per cent, and that of coal, oil and gas had risen to 95 per cent. Back in the 1930s the Soviet Union had hundreds of thousands of windmills and other wind-driven engines which are no longer used. Or take sailing ships which for hundreds of years dominated the seas and oceans. So which energy sources should be regarded as traditional, and which non-traditional? I think that the answer is clear.

Over the past several years public interest has been growing world-wide in the traditional sources of energy with a view to putting them to good use. Intensive research into the utilisation of wind is being carried out in the United States, Great Britain, France, Denmark, the Netherlands. In California alone the number of wind-driven electric power stations increased between 1981 and 1986 forty times to a total of 7,000. Their combined power is now 1,000,000 kw which is equal to the adopted capacity of one nuclear power station in the United States. Wind-driven power stations have become the principal source of electric power in this industrial and thickly populated region of the United States. Today one kilowatt-hour of electric power generated by the wind costs 15-20 cents. According to specialists, by 1990 the cost of electric power obtained in this way will be half of what it is today. In fact wind-driven stations will be fully competitive even in comparison with such conventional sources of electricity as thermal electric power stations and hydro-electric stations. Thousands of wind-driven power generators are working in the mountaineous areas of Romania where they pump water, generate electricity for loggers, herdsmen and geologists. New turbogenerators with a capacity of 100-300 kw have been put to a test.

In the USSR, over the period of the 11th five-year plan (1981-1985) a mere one thousand such installations with a four-kilowatt capacity were produced, whereas the number of wind-driven units of 16 kw is somewhere around 50 or so. Significantly, the wind energy resources exceed the energy potential of all the rivers in the country. Wind energy potential can be utilised only if they are manufactured in large numbers and in a broad range of power capacities so they can be used for different purposes. It is encouraging, though, that the practical utilisation of wind energy has "got off the ground". In the words of the leaders of Minenergo this department "is prepared to start the construction and assembly of large wind-driven power stations and integrate them into a national power grid". In 1986-1990 the first experimental station with two wind-driven power generators, with a power capacity of 1,000 kw, is expected to be launched.

Great hopes have been raised for solar energy to help ameliorate the present ecological situation in the world. Utilisation of solar energy has a long history. We know since our school days that back in 287 B. C. Archimedes set up a system of mirrors to focus sun rays and in this way set the enemy fleet on fire. This is how he defended his native town of Syracuse against the Roman invaders. Very few of us know that the great French scientist Antoine Lavoisier constructed a furnace in which solar energy raised the temperature above 1,000° C. For forty years a solar desalinator built in Chile in 1871 processed 23 tons of water a day.

The intensive development of oil and gas power engineering, as the cheapest sources of energy, has somewhat cooled, but not completely quenched public interest in the utilisation of inexhaustible solar energy. Confronted by the threat of exhaustion of oil and gas, by the contamination and disintegration of the environment as the result of their extraction and burning, people are becoming more and more aware of the need to create solar power generating stations. Such stations are run primarily on photogalvanic elements that transform the energy of solar beams directly into electricity. Their first successful utilisation was on space ships in 1974. In 1975, for example, one solar battery cost 75,000 dollars per one kw at peak capacity, which was 300 times as expensive as one kw of electric power generated by a coal-burning power station. Over literally one decade the situation changed drastically. At present, with the mass production of solar batteries, their cost (reckoned for one kw) has gone down to 1,500 dollars. The cost of one kw generated by a coal-burning station is 1,100 dollars. Considering the fact that solar power installations do not consume exhaustible organic fuel and do not hurt the economy with pollutants, the ecologo-economic effect of such installations will on balance be greater than that of thermal power stations.

More and more work is being carried out to create and modernise solar power stations. One such station of 5,000 kw has been built and put into service in the Crimea. Its power capacity is rather modest by modern standards. It would be quite appropriate to recall that the world's first atomic station, built in the USSR, also had a power capacity of 5,000 kw. A good beginning is half the battle, as the saying goes.

According to Academician N. Semionov, and the corresponding member of the Academy of Sciences K. Zamarayev, the solar beams that fall on Soviet Central Asia contain as much energy in an area of 70 km × 70 km as do 600 million tons of oil. The Kara Kum desert alone can accommodate about 60 such areas. It stands to reason that not all the energy that comes from the sun can be put to use. And yet, even if 80 per cent of potential solar energy is lost, the volume of the electric power generated in the USSR by all types of electric power stations could be obtained within an area of 65 km × 65 km. The fact that intensive solar radiation is limited to relatively few regions in the south of the country should not deter us from the large-scale development of solar power engineering. The problem of transmission of electric power through high voltage lines over thousands of kilometres has already been solved. This makes it possible to integrate heliostations situated at great distance from one another and from centres of energy consumption, into one power grid.

The wide-ranging development of solar power-engineering is no fantasy. In Turkmenia, for example, solar energy is used for pumping water out of deep wells, growing farm produce in hothouses, breeding chlorella, smelting metal, and even for treating people for various illnesses. In future solar energy might reduce the requirements for fossil fuel by 70 per cent, according to some Turkmenian scientists. In Uzbekistan work is nearing completion on the construction of a metallurgical complex called *Solntse* (the Sun). A concentrated stream of sun beams will help obtain temperatures of more than 3,500° C. The complex will produce hundreds of tons of super-pure heat-resistant metal. And all that will be achieved without ecological losses.

The research being carried out by Soviet specialists into the utilisation of solar energy for resolving the shortage of drinkable water in arid areas merits attention.

There is a lot of water on our globe. There is a lot of it even in deserts and semideserts. However, not any kind of water can be used, for man needs fresh, drinkable water, and not salt water. Is there any way to increase its reserves? To provide an answer to this question, it would be well to recall the fact that matter does not disappear without trace. The water used for irrigation does not disappear either. Some of it evaporates, and the rest sinks into the earth by way of subsurface drainage. Most of it forms part of the ground water reserves, but some of it rises to the surface, filling large lifeless lakes, such as the Sarykamysh Depression in Soviet Central Asia.

Both the water from subsurface drainage and other underground bodies of water have a very high salt content. In actual fact, these are comparatively cold and shallow (20-50 m under the surface) reserves of brine of varying, including very high, salinity. Are there many such bodies?

According to I. Zaitsev, the author of the book *Hydrochemistry in the USSR* published in 1986, masses of highly mineralised ground water and salts are accumulating rapidly in drainless depressions in the arid regions of the USSR. A comparatively small area of 17,000 sq km adjoining the northern shores of the Caspian Sea (between the Volga and the Ural Rivers), down to about 20-25 metres encloses 500 cu km of brine of an average of 50 gram per liter. In the whole arid area in the south of the USSR the amount of brine developing in the modern geological epoch in the zone of free water exchange runs into tens of thousands of cubic kilometres.

Many scientists believe that, in order to successfully develop irrigation farming in the republics of Soviet Central Asia and to solve the problem of the dying Aral Sea, it is necessary to add another 20 cu km of fresh water to the existing flow of the Amu Darya and Syr Darya. This additional flow could be obtained by desalinisation of masses of salt water. At present scores of different methods to desalinise this water have been worked out. Among them the most promising is a method of desalination based on the use of solar energy. This method is known as a solar pond, a shallow (2-3 m deep) reservoir filled with salt water. The salt content of its water is lower at the top (a fraction of one per cent, or possibly several per cents). By contrast its salt content near the bottom is very high.

Solar radiation heats up this water near the bottom to as high as 100° C (the highest known temperature was 109° C). Unlike sea or fresh water, the brine becomes heavier, when heated, and not lighter, because the heavy salts dissolve faster at higher temperatures.

The heat capacity of such ponds is very high. Even in winter the temperature in Central Asia does not drop below the 50° C mark. The hot brine automatically separates into the distillate which is completely free from salts, and a still thicker brine.

To obtain the missing 20 cu km of desalinated water, it is necessary to build a "pond" of 20,000 sq km, i. e. 100 × 200 km. Actually it takes more than just one pond to resolve the fresh water shortage. Numerous ponds have to be built in areas unfit for agriculture: 0.5 ha of water surface per 1.0 hectare of irrigated area. Each pond is equipped with an electrical installation (plant) consisting of a desaliniser, a low-pressure steam turbine, and a steam condenser. Desalinisation of water here is achieved not by expending electric power but by generating it. The planned power capacity which such desalinising plant can yield is estimated at 200,000,000 kw which is equal to the existing combined power capacity of the thermal electric stations in the USSR.

The progress being made in the development of power engineering in this direction can fundamentally transform its traditional structure, and make it ecologically harmless. I am aware that this assessment is largely hypothetical, because in practice this problem may not be resolved so easily on such a large scale. There may also be many unforeseen circumstances, as they occur everywhere. All that is certainly worth the effort, for our aim is to save the Aral Sea and solve such vital problems as water conservation, to protect the land from excessive salinity and to obtain ecologically clean energy. To back away from their solution is not only unwise, it is a crime against our children and grandchildren, all the more so as we have a lot of practical experience of creating such complex plants. Back in 1970 the solar pond in Uzbekistan was studied by Y. Usmanov, an assistant professor at the Tashkent Technological Institute. Over the past several years similar plants have been set up in Chile and Israel. Moreover, the funds spent on obtaining electricity at such plants do not exceed the cost of its production at major thermal power stations.

The production of biogas and its transformation into electric energy is widely regarded as a very promising direction of the ecologically harmless development of power engineering. Biogas is the product of the anaerobic methane fermentation. For its heat generating capacity (about 5,500—6,000 Kcal per cu m) biogas can match such widely used types of fuel as kerosene, coal, and butan. As for the cost of production of an equivalent amount of thermal energy, biogas is half as expensive, and even one third as expensive to produce, according to UN data. This new development in energy production is valuable because it essentially imitates processes taking place in nature itself.

The disintegration of organic matter (biomass) without the access of air to it, notably in sedimentary rocks, takes place continuously, bringing forth a natural gas, methane. There is about 800 billion tons of biomass on our planet, with about 200 billion being renewed every year, which is roughly equivalent to 100 billion tons of oil for their energy potential. The biomass contains plants, animals, microorganisms, also agricultural and urban wastes.

All these wastes could be converted into biogas, consisting of methane and carbon dioxide, equal to 100 million tons of equivalent fuel annually. What is left after processing can be converted into 150-180 million tons of high quality organic fertilizers, containing 6.25 million tons of nitrogen, 3 million tons of phosphorus, and 7.5 million tons of potassium oxides in the form of salts that can easily be assimilated by plants.

These calculations are not the product of idle fancy. Some farms in Latvia, for example, use biogas facilities in their hog houses. The gas obtained from the anaerobic fermentation of manure is piped into their heating systems and, which is no less important, the pig manure which gives so much trouble to farmers is thus utilised, leaving the floor clean. The residue in the fermentation tank contains compounds of potassium and nitrogen which go into the production of a good organic fertilizer. This is an important achievement, considering the fact that the conventional method of production of organic fertilizers, such as composting, consumes 30 and even 40 per cent of these valuable elements. Already now an animal farm with 200 head of cattle can produce 90,000 cu m of biogas a year. It has been estimated that all large farms and poultry plants in Latvia can produce an amount of biogas equivalent to 18 million tons of equivalent fuel.

At present biomass constitutes 3 per cent of the energy generated in the United States, 5 per cent of that in the countries of the EEC, about 3 per cent in the Soviet Union, and 2.5 per cent in West Germany and Britain. The situation is somewhat different in China. According to the United Nations a total of 7 million biogas generators (mostly in private use) produce 100 billion cu m of gas a year. This equals 100 million tons of equivalent fuel.

In the view of Soviet experts, the outlays for production of biogas from animal waste and its conversion into heat and electricity can be recouped over a period of two or three years. It has been estimated in the United States that the conversion of 60 per cent of the manure accumulated annually on American farms into biogas would cut down importation of oil by 30 per cent.

It goes without saying that the biomass will never fully replace either oil, or any other fossil fuels. However, it will in time hold an important place in power engineering as an additional, ecologically "clean", constantly renewable source of energy. This is borne out by the fact that most countries have programmes for the more intensive use of the biomass, in spite of the drop in the price of oil on the world market.

Also promising are the areas of energy production based on utilisation of geothermal energy, the energy of high and low tides. Here is an example.

It took a mere year to build a geothermal electric power station in California. It operates on hot water (90° and 160° C) that circulates 150-300 m below the earth's surface. The electric power station is made up of 26 modules, 1,200 kw each. Since conventional steam turbines cannot operate economically at such a low water temperature, the turbines of the electric power station operate in accordance with a special cycle using a liquid heat-transfer medium, which has raised the thermodynamic effect to 15-25 per cent.

The new discovery is justly qualified as a true scientific and technological breakthrough. Almost immediately after the first publications of press reports on high-temperature superconductivity, many countries, including the United States, the Soviet Union, Japan, the People's Republic of China and Great Britain, launched numerous programmes of research into the new class of materials and their practical application.

Back in the spring of 1987 some US congressmen suggested the institution of a wide-ranging superconductivity programme financed mainly by the Federal Government, also economic and juridical measures that encouraged private businesses to launch wide-ranging research into the commercial development of the new superconductors. A mere six months after this new discovery had first been reported the US Administration formulated the principles of its scientific and technological policy for the realisation of superconductivity potential.

Scientists the world over interpret the new discovery as a technological revolution, as a new era in science and technology, and the philosopher's stone of the 20th century. Some American specialists believe that commercial utilisation of superconductivity can boost U. S. industry and the economy as a whole. So far the scientific and technical progress has been associated with the progress of the modern technologies, whereas the emergence of superconductivity will prompt fundamental changes in the key sectors and in the vast areas of the economic infrastructure. The revolutionary changes will affect power engineering, transport, the electric power supply system, i. e. sectors whose potential was thought to have been exhausted.

The unique possibilities of superconductors stimulate the development of new types of technology. Experts at Japan's Ministry for International Trade and Industry have assessed the prospects for the commercial utilisation of superconductivity as "a fantastic world of new branches of production". The forecasts made at some universities and research centres of Japan say that in 1995-2000 the country will launch trains on a magnetic suspension, ships with a superconductive engine, superconductive power lines, electric power storage packs, magnets for thermo-nuclear synthesis. However, these unique prospects do not absolve us from the need to work on the problem of power supply.

The thrifty expenditure of electric power can save anywhere between 50 and 75 per cent of the funds spent on the growth of fossil fuel extraction.

However, the concept of "energy saving" should be given a wider interpretation than just measures to eliminate mismanagement. Nor should this term be understood as an attempt to limit the consumption of energy to the detriment of production, or as some sort of "energy starvation".

The concept of "energy saving" as a global strategy is an energy policy which maintains the same level of comfort by reducing the expenditure of energy through the introduction of new less energy-intensive technologies, and by rational distribution and utilisation of energy resources.

What are the prospects for power conservation? A group of scientists at Princeton University, jointly with specialists from other countries, have drawn up a scenario of how the power industry should develop in the world, using energy conservation techniques.

According to this scenario, energy consumption will, by the year 2020, be a mere 11.2 trillion wt (in the 1980s this level was 10.3 trillion wt). Moreover, per capita energy consumption in industrially advanced countries is expected to go down from 6.3 kwt to 3.2 kwt and to increase from 1 kwt to 1.3 kwt in developing countries. Moreover, in 2020 the per capita energy consumption in the USA is expected to be equal to that in the Soviet Union in 1987.

It is very important that we should already now be able to estimate, first, the amount of energy saved and, second, the limit of energy consumption over the long term, so as to be able to plan better both the development of production and the consumption of energy. This should be reflected in our investments policy. Funds should be invested primarily not in the growing extraction of energy resources, but in the development of technologies and industries that consume less energy.

To make more effective use of energy in the national economy, and consequently, to ensure circumstantiated development of the fuel and energy complex, progress must be made not only in the power industry but also in mechanical engineering. The energy crisis in the early 1970s stimulated the development of energy-saving machinery and technological processes. For example, in 1975 the United States passed a law on energy saving which said that cars to be manufactured in 1983 had a petrol consumption limit of 8.5 litres per 100 km, as compared to 17.5 litres limit for cars manufactured in 1973. These demands set for car manufacturers were carried out successfully.

Japan has made a dramatic headway in the manufacture of economy-class cars. At the 26th world exhibition the Isuzu company put on show a ceramic engine car which was 14 per cent lighter and 30 per cent more economical than traditional models. The engine had no cooling system and could operate on practically any fuel. The Toyota company exhibited a super-economy class car which, at a speed of 60 km/h expended a mere one litre of petrol over a distance of 54 km. Other novelties were just as impressive. Our car industry has also made some progress in this direction.

Energy saving is only one side of progress in automotive manufacturing. Another no less important requirement is the ecological cleanliness of the car engine. The 58th international car show held in Switzerland in 1988 displayed 1,200 car models from 30 countries, including the Soviet models — *Volga* and *Lada*. Regrettably neither of these two cars will grace the car markets of Western Europe for the simple reason that they do not meet the new strict ecological standard. Ecological safety is one of the mandatory requirements in car manufacturing now. Increasingly popular is a car propelled by pressurized gas which not only produces 30 per cent less pollution with its gas exhaust, but also saves liquid fuel and in this way reduces its overall running costs. Ecological experts are of the opinion that a radical switch should be made from conventional petrol to gas fuel. Economically such a switch would save 570 roubles annually for every car thus converted from petrol to gas. Considering the size of our automobile fleet such conversion would mean billions of roubles saved.

There are still more radical projects for modernisation of cars. The institute of organic catalysis and electrochemistry of the Academy of Sciences of the Kazakh SSR has developed a method of obtaining hydrogen from aluminium which, when acted upon by helium, indium, or tin can easily dissolve in water. This chemical reaction abundantly gives off hydrogen which can be used as fuel for different purposes, including its utilisation in internal combustion engines. Now imagine how pure the air in our cities would be if all cars used hydrogen instead of petrol. The point is that after burning, hydrogen leaves nothing but water behind. Besides the combustion process is highly effective. A mere gram of aluminium can thus produce over one litre of hydrogen. An important feature of this reaction is that it can be easily controlled. The same one gram of aluminium can be dissolved within one second, or one minute, or any other time. The reserves of raw materials out of which this metal can be produced are very great. It can, for instance, be obtained from the slag of thermal power stations at Ekibastuz where millions of tons of this material have piled up over the years.

Significantly, this method of hydrogen production discovered by Soviet scientists is practically waste-free. When the metal mixture comes in contact with water, only aluminium gets dissolved, whereas the activators settle down on the bottom of the reactor and can be re-used.

3. Agriculture: Intensification on the Basis of Biotechnology

In accordance with Soviet economic strategy, agriculture, like all the other sectors of the national economy, will have to go over to greater intensification. The idea of intensive farming is to obtain more produce from a smaller area and, which is very important, at lower per unit costs.

The possibility of using less land for agricultural purposes is of cardinal importance, considering the constant growth of the population and the shrinking per capita of farming area. Intensification also makes it possible to take relatively poor land out of operation, as it requires more labour and funds.

Reduction of the cultivated land area and of the cattle population means less labour and money inputs. The farm labour thus released can be used effectively in other sectors of material production and in non-productive spheres, and in this way can increase both the national income and the public consumption fund.

Besides the concentration of farm production on a smaller area, with the best soil, can release considerable capital investments and improve the structure of their utilisation. Every year an average of 147 roubles is invested for production per hectare of tillage. This means that the conservation, reservation and subsequent cultivation of even one fifth of the arable land can save the nation about 6.7 billion roubles a year.

The same can be said about the expediency of reduction of the cattle population. As we mentioned earlier in this account, the cow population grows much faster than their milk yield. A large proportion of the cow herd is made up of dry cows. The growing cattle population calls for large-scale and costly farm development projects. For example, the cost of construction of just one stall for milk cow is somewhere around 5,000 roubles. A reduction of the milk cattle population by at least 25 per cent amounts to a saving of 40-50 billion roubles of capital investment. Moreover, the culling of low-grade animals and the reduction of the cow population would make it possible to provide the remaining livestock with more and better feed, raise their productivity, and would in this way make up for the fewer number of head in the herd.

It is worthy of note that reduction in the size of cultivable land (and that of the livestock), with machinery, mineral fertilizers, animal feed, etc. supplied in the same quantities, would sharply raise the per unit effectiveness of farm machinery. At the same time farm produce would be less labour-, capital- and energy- intensive.

American experience shows that positive results can be achieved with less inputs.

Table 17

Dynamics of Inputs and Results in US Agriculture (1970—for 100%)

Year	Farm production	Energy consumption	Energy intensity of farm produce	Labour productivity
1975	113	111	98	135
1980	123	102	83	170
1985	132	90	68	197

The above figures show that intensification in agricultural production on the basis of scientific and technical progress, including that in *biotechnology* is a matter of priority.

The advantage that biotechnology holds over the technocratic approach to agriculture can be judged from the fact that biotechnology is based on the maximal utilisation of the natural factors of reproduction, and that it restricts technogenic factors which, as a rule, are incompatible with ecological requirements. This is why it is so important to assess this advantage for working out a strategic concept of agricultural development. This is what T. Maltsev, an honorary member of the Academy of Agricultural Sciences, said to this effect: "Land is a living organism which has its own laws of development. These laws must be studied and must be reckoned with. The land must not be mistreated."

At present scientists in different countries are trying to sum up the data they have accumulated over centuries in order to better understand the global role of the soil in the biosphere. The soil is not only a source of farm production. It is also a very important element of the entire biospheric and geospheric mechanism. For example, it regulates the flow of different gases, such as carbon dioxide, hydrogen, methane, and some other organic substances, all of which affect the composition of the atmosphere. When we disrupt the balance in the atmosphere, we also disrupt very complex links, and mechanisms of the biosphere as a whole. The soil must not be treated as some sort of a mechanical substrate of clay, sand and water, a substrate that can be brutally crushed by the shells of a truck, sloshed with water and stuffed with chemicals. The soil is a complex living organism which, once destroyed, can never be restored again. And destroyed it can be by irrational use of technology, chemicalisation and amelioration.

So-called rehabilitative agriculture has over the past decade been rapidly taking over the United States and Western Europe. The idea of this method is to reduce the cultivation of the soil to a minimum, to stop using mineral fertilizers and herbicides, to fight erosion (notably through soil conservation), to arrest disintegration of humus which is gradually disappearing, to cultivate leguminous plants capable of accumulating nitrogen. It is also important to apply so-called green fertilizers. At present, somewhere between 15 and 17 million hectares of ploughland in the United States are withdrawn from agricultural use for periods of 5 to 7 years. This is done in accordance with the Agriculture Act of 1985 which also requires the Federal Government to compensate the farmers for the ensuing financial losses. According to the editor of the *New Farm*, the organ of the Agriculture Welfare and Recreation Association, more and more American farmers follow the principle "it's better to cooperate with nature than to fight it". The membership of this Association grew from 7,000 in 1982 to 60,000 in 1985, and is still growing rapidly.

Any rise in the crop yield today increasingly depends on the successful work of selectionists. In Hungary, for example, biologists developed new varieties of short-stemmed highly resistant wheat with a yield as high as 75-100 centners/ha. They have also developed new varieties of maize with a yield of 100-150 centners/ha. The quality of these new varieties of wheat and maize is so high that American farmers purchase their seeds in large quantities.

In Western Europe farmers take in 60-70 centners of wheat per hectare on the average. More than half the increment in the yield of wheat, maize, and sugar beets comes from new varieties and hybrids, i. e. as the result of utilisation of genetic factors. Among the greatest achievements here is the development of semi-dwarf hardy varieties of wheat with a neutral protoperiodic reactions, also of maize hybrids with different vegetative periods, tomatoes fit for cultivation and harvesting by machine, sugar beets and sun-flowers, and rapes free from toxic substances.

Soviet selectionists have also developed a number of high-yielding crop varieties and hybrids. When tended carefully these plants can have high yields on farms equipped routinely with machinery and chemicals.

On a collective farms in the Krasnodar region, some wheat varieties yield 60-85 centners of quality grain per hectare. Some farmers in the Rostov region take in 100 centners of hybrid maize per hectare. Significantly, such harvests are obtained here without irrigation, in spite of the contentions of certain zealous soil ameliorators.

I must say that this is possible not only in the southern regions with their rich black earth. The good harvests of high-grade wheat can be raised in any climatic zones and on any soil. The Lenin collective farm in the Tula region (not far from Moscow) yields 54 centners per hectare of zoned wheat on average. On the Zarya collective farm in the Kirov region where the climatic conditions are not excellent for wheat growing, the farmers' team headed by V. Vershinin takes in 36 centners of wheat per hectare. Significantly, its production costs are 35 per cent of those planned. The yield of fodder crops is also much higher than the average for that collective farm. On average one farmer, a member of the team, raises 36,000 roubles worth of farm produce. The results are certainly very impressive, considering the fact that the average yield of cereals for the country, even in good years as was 1987, was 18 centners per hectare, whereas the total output per farmer was worth 7,000 roubles a year. We have cited these figures not for showing what records could be achieved. There are hundreds of such examples. What we want to prove is that it is possible to intensify farm production on the basis of modern biotechnology.

Seed farming plays the decisive role in raising the crop yield. In the old days people used to say: "Bad seed, bad breed". How could we expect to have a good harvest if, according to a review of the quality of seed grain in February 1988, 20 per cent of its stocks were pronounced non-grade, and 15 per cent of this amount was found non-germinant. Many farms have no seed stocks. Dependence is a disease which is a big drain on the resources of any country. For example, the non-zoned grain that some of them import reduces the crop yield by 3-4 centners per hectare. Neither chemicalisation, nor intensive technology can make up for this loss.

Special mention should be made of biotechnology as a means of plant protection. For some reason many people think that no weeds or plant disease can be dealt with without chemical agents, but this is a grand delusion!

The very fact that today we are doing so much biotechnological research into the ways and means of fighting weeds, pests and disease of agricultural crops goes to prove the inefficacy of the traditional chemical methods of combating them. American scientists have discovered 430 insect species that can stand up to insecticides; about 100 diseases of cultivated plants and 36 weed species have developed resistance to pesticides.

In the period from 1975 to 1985 American private companies alone invested about 4,000,000,000 dollars in biotechnological research. Moreover, ten leading biological firms (out of more than 300) received 63 per cent of this sum. Over the said period 633 million dollars were spent on biotechnological farming research, including 479 million dollars in the field of plant breeding.

At the same time the production and application of chemical herbicides is expected to go down.

Table 18

Production of Farming Chemical Agents in the United States (thousand tons)

Years	Herbicides	Insecticides	Fungicides
1975	357	299	70
1980	365	229	65
1984	254	78	24
1984 (in % to 1975)	69	26	34

The above shows that the production of chemicals used in agriculture in the United States went down, whereas the crop yield rose. In the Soviet Union the tendency is exactly the opposite. The supply of herbicides to collective and state farms between 1970 and 1986 increased 3.5 times whereas the crop yield remained at the same level, and even showed a decline in some farm crops (cotton and sun flower). At the same time some farmers managed to do without herbicides. One should not forget that the rice grown without herbicides is a very nutritious diet, which cannot be said about the rice grown on toxic chemicals.

This passion for chemical agents is cooling off in many places in the Soviet Union. For example, in Moldavia 53,000 tons of pesticides were used in 1984 and only 24,000 tons in 1987. Here they are being replaced by biological methods of combating pests.

Today Moldavia has sixteen biolaboratories. Over the past several years the total area of farm crops and plantations protected by biomethods has grown from 223,000 to 1,250,000 hectares.

It goes without saying that biotechnology cannot fully replace industrial methods of farming.

What could be done, instead, is to radically change methods, and make them more ecologically healthy. This applies first and before all to soil cultivation techniques. Over the past ten years such techniques have changed dramatically. In the industrially advanced countries the use of labour-saving machinery and soil-protective methods have been gaining momentum. In the United States, Britain and West Germany tractors with about the same power capacity as ours weigh almost half as much and are equipped with accessories that perform 5-6 operations simultaneously. Such farm machines cultivate and harvest sugar beets sown with seeds of great germinating power in a mere four runs across the field and take in 500 centners from ha of this vegetable without expending any manual labour. By contrast, Soviet tractors "steam-roll" just one field 12 and even more times. This involves an excessive expenditure of fuel, increases labour expenditure five times and crushes the fragile structure of the soil. Boardless ploughing is taking over in all countries. In the United States the number of standard steel ploughs manufactured in 1975 was 56,700 and by 1980 their number had dropped to 27,000. Today their production has stopped altogether. We shall add here by comparison that the Soviet Union manufactured 220,000 ploughshares in 1986 which exceeded the total number of ploughs manufactured in all the other countries in that year.

Nevertheless, ploughless methods, minimal and especially zero soil cultivation are beneficial for agriculture. These methods make it possible to preserve soil structure, conserve moisture, raise the fertility of the soil and in this way to increase the productivity of the farm fields, also to cut labour, materials and energy inputs. American agricultural practices have shown that in the minimal cultivation of the soil, the expenditure of fuel drops by 23 per cent, and in zero cultivation it goes down by a whole 69 per cent. Similarly, the expenditure of living labour decreases by 14 per cent and 51 per cent accordingly, and the utilisation of farm machinery and equipment by 25 per cent and 45 per cent. In the 1970s and 1980s the introduction of zero and minimal soil cultivation proceeded apace. From 1972 to 1983 the area of zero cultivation grew from 1.4 to 5.3 million hectares, or by 270 per cent, and the area of minimal soil cultivation increased from 10.7 to 45.7 million hectares, or by 320 per cent.

As a result, in the United States the proportion of the area where soil-protective techniques are used grew from 8.9 per cent to 37.8 per cent. In the 1980s the rates at which new soil-protective techniques were introduced rose markedly: from 1972 to 1980 the protected area increased by 5-6 per cent, whereas from 1980 to 1985 it grew by 10-12 per cent.

Farming novelties are gaining ground in the Soviet Union, too, although this process is very slow. One such example is the Poltava variant of soil-protective cultivation, the result of more than ten years of experience. Over this period the fields cultivated without the plough have yielded an appreciable accretion of grain harvest. Moreover, labour productivity has grown by 37 per cent, whereas fuel expenditure has gone down by 36 per cent. As a result, Poltava collective and state farms have raised their incomes by 487 million roubles. Today practically all the arable land in the region is cultivated without the plough. In 1987, the local farmers have raised and collected 37.7 centners of wheat per hectare, and 43.8 centners of winter wheat. Never before did the Poltava region have such high crop yields. These are the highest anywhere in southern Ukraine. This, however, is not the limit by far. There are many farms which take in 40 and even 50 centners of wheat per hectare regardless of weather, high yields of other crops and which at the same time have good results in livestock husbandry. Many collective farms have stopped using chemicals altogether.

Afforestation offers great possibilities for ecologisation of farm production, for amelioration of the depleted arable land and for raising crop yields. Planting afforestation belts along the perimeter of farm fields is an old practice in this country. Back in 1892 the celebrated Russian soil scientist Vladimir Dokuchayev organised a commission for testing various methods of forest and water management in the steppes of Russia. A team of enthusiasts like himself took a mere five years to set up an experimental farming complex in the Stone Steppe (now the Talovsk district in the Voronezh region). This system includes a system of afforestation belts, ravine ponds and vast tracts of virgin feather-grass steppe. This experimental model is still in use, which makes it almost 100 years old, and has demonstrated its ecological and economic soundness. This nature model has stopped wind and water erosion of the soil, raised ground waters to an optimal level, and its entire area is known for good and stable harvests of farm crops. When severe drought occurs 3 or 4 times every ten years, the relation between harvests of cereals in this nature zone and elsewhere in the region is 5:1.

Dokuchayev's ideas and the century-long experience of the nature zone he created have helped work out an optimal proportion of ploughland, meadows, forest, and ponds which, considering the climatic, top soil and subsoil conditions, can be applied over the vast areas of steppes and forest-steppes in the south of the European part of the country.

Farms that have an optimal network of afforestation belts raise stable bumper crops. One such steppe zone in the Stavropol region where water supply is both unstable and insufficient, but where dry winds and dust storms are frequent, serves as a good example. Altogether, there are 107,000 hectares of protective afforestation belts which account for about 1.5 per cent of the entire ploughland. However, the effect of afforestation belts in this region varies from one farm complex to another.

In some places afforestation belts take up a mere 0.5 per cent of the arable territory, and in others this figure rises to as high as 4 and even 5 per cent. Typically, on the farms where the area of afforestation belts is the highest (about 5 per cent of the ploughland), the crop yield in similar soil and climatic conditions is 50 per cent and even 100 per cent higher than in areas where afforestation is 0.5-1.0 per cent. This is easy to explain, because the limiting factor of cereal crops is lack of moisture. The afforestation belts not only hold back the snow in the fields, but also evenly distribute the moisture and in this way reduce its evaporation. They also regulate the hydrological regime, prevent the baneful effect of dry winds and dust storms, and check the spread of wind and water erosion. Elimination of soil erosion, which blights farmers everywhere, would help raise the crop yield by no less than 30 per cent.

Afforestation has tremendous economic potential. Here is an example. For one rouble invested in agriculture the average returns are 72 kopeks. In plant growing this figure rises slightly to 1 rouble and 07 kopeks, whereas in forest-protected areas the returns are 2 roubles and 29 kopeks, i. e. more than three times over the average capital investment.

The setting up of one hectare of forest belt requires 200-350 roubles, depending on local conditions. This sum can be recouped within 0.3-0.7 years, with an average of eight years for the whole country. According to the Lithosphere Institute of the Academy of Sciences of the USSR, to protect arable land from dehydration and wind erosion, the Soviet Union needs 4.7-5.6 million hectares of tree plantations to protect the fields and to regulate the water regime. In different regions of the country the area of such plantations varies from 2 to 5 per cent of the ploughland. This by no means is a loss of good land. On the contrary this is the most important condition for protecting and raising the fertility of cultivable land. In future the Soviet Union will have to spend between seven and eight billion roubles for this purpose until the year 2000. Actually these expenditures are not so great, considering the fact that every year the government allocates more than 30 billion roubles of capital investment for agricultural purposes. The effect of afforestation for soil protection is tremendous. According to calculations, the realisation of this programme will increase the annual grain harvest by 60 and even 80 million tons.

Regrettably, land protective afforestation in this country is not given sufficient attention. Over 1981-1985 a little over 200,000 hectares of afforestation belts were planted. In the Russian Federation the annual forest plantation area in 1980s actually dropped below that of the 1970s. Such a rate of afforestation in our steppe regions are much too slow. What we do need is a total of no less than five million hectares of field protective and water regulating forest plantations. To attain this objective, at the present rate of forest plantation, would take many decades, which is absolutely unacceptable. This is why the rate of annual afforestation must be raised four or even five times already in the near future.

* * *

And in conclusion a few words about the possibilities opened up by biotechnology in agriculture.

The average milk yield per cow in the Soviet Union is surprisingly low. Although it has, over the past two years, risen somewhat, it still remains at the level of 2,600 kg a year. In the United States, by contrast, the average milk yield had, already in 1985, reached 5,910 kg, and in California it is 7,650 kg per cow. These are average figures. Some individual specimens, and that not only in the United States, but also here, in the Soviet Union, show fantastic milk yields.

For example a cow called Rossiyanka from the Rossia breeding farm in the Chelyabinsk region gave 18,086 kg of milk over just one lactation period. To produce one kilogram of milk this cow eats about one third the amount of feed as the average cow in that area. Its maximum daily milk yield exceeded 82 kg. A cow called Helen in the United States recently exceeded this record, with its annual milk yield at 25,000 kg. The high-breed herd in the Lenin collective farm in the Tula region has an average annual milk yield of 5,700 kg per cow.

In the context of these figures, it is difficult to make out those of our managers who keep cows with a milk yield lower than that of a goat. Joking aside, there are such cows, too. At the Lenin collective farm in the Michurinsk district (Tambov region) local managers are quite content with their cows' milk yield at 2.1 kg a day. And at the Vperiod k Kommunismu! (Forward to Communism!) collective farm in the Kirsanov district of the same region, the average milk yield is even lower: 1.7 kg per cow per day. The reader may ask: "what is the use of keeping such cows, considering all the work and funds that go into their maintenance?" The only result of such management is economic loss and moral damage for cattle breeders. American scientists believe that the use of biotechnological methods will in future help to raise the milk yield per cow to as high as 20,400 kg a year.

Biotechnology also has vast potential in cattle feed production, in the protection of animals against disease. It can also increase meat productivity and improve the technology of cattle fattening. In some countries, notably the United States, Britain and New Zealand, farmers engage in specialised beef cattle husbandry. In the Soviet Union such specialised beef breeding is not practiced. The earlier official farming policies for raising combined meat and dairy cattle proved to be wrong in many ways. One such result is that we have practically lost the ancient Kalmykian breed of beef cattle. Our selectionists have so far failed to raise a breed of cattle that would match Kalmykian cows for productivity and quality of meat, for their ability to adjust to local pastures. Not accidentally, the average live weight of a cow sent to meat-processing plants in the USSR is 352 kilogrammes, whereas in the United States it is 40 per cent more (497 kg).

We should add here that on some of our farms which strictly follow recommendations of biotechnology and where the necessary socio-economic conditions are set up for the farmers, the results are no worse than those at average farms in the United States.

For example, the state farm named after the Sixtieth Anniversary of the USSR, in the Belgorod region, every year raises 18,000 bullocks, each one of which, over fifteen months, build up a weight of 430-450 kg and in some cases even as much as 560 kg. Moreover, one centner of weight accretion corresponds to 5.6-5.8 centners of feed units, whereas at other state farms the expenditure of feed is almost twice as great.

Similar results have been achieved in the Druzhba state farm in the Vologda region. At this state farm bullocks are put out to fattening when they are two months old, and thirteen months later the animals build up their weight to 450 kg, whereas the average period necessary for fattening to such weight is more than two years.

It is easy to imagine how much effort and money could be saved if the experience of this and other such farms were introduced nation-wide.

Measures to determine the optimal area of cultivable land and the optimal size of the cattle population, utilisation of progressive technologies of production based on the latest achievements of genetics, biological selection, seed farming and agrotechnology, also measures to conserve the fertility of land would, in combination, make it possible to overcome the old practice of increasing capital intensity of agricultural production, and would in this way make it possible to coordinate the development of the agro-industrial complex with the tasks of preservation and renewal of natural resources.

4. The Ecological Aspect of New Technology

The strategy of the social and economic development of the Soviet Union on the basis of utilisation of scientific and technological achievements, the orientation of the economy towards the primarily intensive development call for instituting effective state ecological control over new machinery, technology and materials. All that is necessary in order to ensure environmental protection and rational utilisation of natural resources.

At present the observance of Soviet nature protection legislation is not backed as it should be by a complex of measures drawn up by ecological experts. Such observance is mainly limited to engineering, economic and ecological estimates concerning design plans and specifications for the building of large-scale projects and major production complexes. Moreover, such estimates are geared to departmental interests and boil down to coordinating relevant sections of building and other projects by government ministries and departments with state supervision agencies, certain offices of other ministries and departments responsible for the observance of statuary requirements for the protection of the natural environment and its components.

Thus, the government ministries and agencies, i. e. users of natural resources, themselves outline nature protection measures.

The main shortcoming of the present practice is that the norms and standards of nature conservation have not been integrated into a system, that they are not related with one another as are the various components of the natural environment. They also lack standards of the ultimate anthropogenic pressure upon the environment by individual industrial enterprises or their groups that operate on natural resources.

This explains the low effectiveness of the nature protection measures being implemented by the users of natural resources. It is necessary to set up a system of expert control that would cover all types of design plans and specifications ranging from the master plan for the development of the production forces of the USSR down to technical documents on the construction and exploitation of industrial enterprises, on the production and utilisation of various types of products.

This gives priority to the following functions of the state bodies of ecological expert control:

to reveal the factors affecting nature components specific to the activities involving the manufacture and application of new machinery, technology and materials;

to assess direct and indirect effects of these factors on human health, on plant and animal life, also the quality of the air, water, soil, noise pollution, and other components of the natural environment;

to work out alternative measures to neutralise negative effects on the natural environment arising from different types of economic activity.

Ecological examination of technical documents concerning production facilities and their installation has to be undertaken by standing commissions of experts appointed by the Council of Ministers of the USSR and the Councils of Ministers of union and autonomous republics, by government ministries and departments, by district and regional Soviets of people's deputies.

The main functions of such standing commissions for ecological examination are as follows:

to make ecological assessments of industrial and other activities;

to assure, together with state supervising bodies, ministries and departments, measures to carry out recommendations set forth on the basis of these assessments;

to sum up the results of ecological examinations and to draw up proposals for improving laws on environmental protection, methods of carrying out ecological examinations and measures to develop ecological standardisation.

The conclusions drawn by an ecological commission of experts must provide a basis for any future technical documentation.

The necessary functioning condition of the state ecological commission of experts is to control the quality of conclusions and the efficiency of standing ecological commissions of USSR ministries, departments and also the territorial and regional Soviets of people's deputies which should be effected by the authorised state management bodies responsible for ensuring the protection of the environment and rational utilisation of nature reserves.

Today environmental protection in the Soviet Union does not fully meet the requirements of existing nature conservation legislation, or the requirements of the decisions and edicts of the government on environmental protection and on the rational utilisation of natural resources.

One of the basic reasons for such a situation is the lack of a routine for initial complex assessment of possible changes in the natural environment, also of quantitative and qualitative changes of proven or potential natural resources that are of particular significance to the national economy.

This vicious practice leads to tremendous economic, social and ecological losses worth tens of billions of roubles a year. The main source of this damage is the destruction of fertile land, forests, water sources, also mineral wealth, despoliation of hunting grounds, destruction of rare types of animals, fish, medicinal plants, depletion of the genetic stock of animals and plants throughout the country. There is much social and economic damage inflicted upon housing, deterioration of ecological conditions in residential areas, the loss of architectural and historical monuments, of unique monuments of nature itself.

The construction of hydro-engineering, drainage and irrigation facilities on the Volga, Dnieper, Don, Kama, Ob, Yenisei, Angara and other big rivers in this country has led to flooding of millions of hectares of arable land and forests. This, as a rule, are the best argricultural lowlands, which from time immemorial have been used as a source of valuable and cheap feed for livestock, i. e. the natural foundation for the development of dairy farming. The damage being inflicted upon the national economy goes beyond the loss of arable land and pastures. In the Ukraine, for example, hundreds of cities, industrial and farm communities have been damaged by partial flooding.

Full or partial flooding of the land, of residential and production areas is not only the result of the building of hydrotechnical facilities in the past. The process is still continuing. The current construction of the Cheboksary Hydro station on the Volga and the planned construction of the Sredne-Yeniseiskaya Hydro (in the middle reaches of the Yenisei) in Siberia and the Katun Hydro in Altai (south-western Siberia) may have similar negative consequences.

Open-cut extraction of iron ore in the region of the Kursk Magnetic Anomaly leads to the loss of the most precious black earth, our great national wealth, in the centre of Russia. This massive extraction of iron ore also leads to serious disruptions of the hydrological regime in this region, to the deterioration of the quality of water, including drinking water. Besides this depredation of the soil causes dehydration and desiccation of vast tracts of densely populated and developed areas.

The construction of oil pipelines and gas pipelines in Western Siberia and in some areas of the North inflicts tremendous damage upon the natural environment there. This can be seen in the thawing of permafrost, in the disruption of the established routes of migration of reindeer, in the disruption of hunting and fishing, destruction of tundra plant life because of the destruction and pollution of the environment.

Great damage has been inflicted upon the natural environment by the construction of the Baikal-Amur Railway, the Dnieper-Bug hydro-engineering complex, and some other major projects of this kind.

Typically, the State Committee for Construction and its agencies start work on territorial complex environmental protection plans after the building project has been finished or when it is still under construction. Many negative effects on natural systems could be avoided, if the possible negative consequences of such nature-affecting projects could be duly prognosticated, and if the development of nature protection measures preceded the construction of these projects.

We must admit that to have this job done by any particular departmental agency is rather difficult, because the effects on the natural environment are varied and complex and can sometime come to light only after a long period of time. The best ways to establish such negative effects, to develop adequate measures to prevent such consequences or to reduce them to a minimum could be worked out by scientific institutions in cooperation with sectoral R&D organisations.

Of particular importance for improving ecological investigation by teams of experts is to move from the assessment of completed plans, samples of techniques, or technological methods to examination of ideas, hypotheses, concepts of development of production forces, technical and technological solutions of new problems.

Earlier in this account we cited many examples of how to radically improve methods of the use of nature on the basis of scientific and technological progress. The reader has every right to ask: why is then the natural environment deteriorating so fast? Why aren't the possibilities of conserving the natural environment as provided by the scientific and technological revolution being properly realised?

There are several reasons for it. In the first place, the insufficiency of research has left many technological problems unfinished. Another reason is the operation of the cost-prone mechanism. However, the main and decisive factor of retardation is mismanagement, also departmentalism and its corollary: the merciless, smothering bureaucracy. How to eradicate this main vice of the existing system of nature use is dealt with in the next chapter of this book.

Chapter Four

WHO PROTECTS THE ENVIRONMENT IN THE USSR AND HOW?

1. Utilisation of Natural Resources: Organisational Structure and Management

> The land and everything on it had from time immemorial been in a balance supported by rock, forest and water. But then came Man who upset this balance and later took on the hard work of redressing it.
>
> *Mikhail Prishvin*

I hesitate to use the words "management" and "managerial" because they sound loaded. We use these terms much too broadly and often distort their meaning. We are forever "managing" something but do not always do it right.

The very concept of "management" is becoming more and more devalued and is redolent of bureaucratic red tape. Hundreds of thousands of numerous big and small institutions and offices are called " managerial". As a rule these departments do not "manage" anything except may be the massive stream of paper-work. The principal, if not the only, method of management they use is the imposition of all kinds of bans. However, even then this concept is valid, and no nature conservation activity can do without it. The important thing is to understand correctly the meaning and substance of "management". No progress would be possible without management. Even the spoon at dinner has to be "managed". This simple art of governing is within reach of everybody. It is much more complicated to "manage", or steer, a car. Both professional drivers and amateurs learn its intricacies fairly soon although with a varying degree of success. By contrast, flying a spaceship is a job for highly skilled specialists operating sophisticated electronic computers.

However, the above three examples are about controlling technical systems of varying complexity. As for environmental protection it is directly linked with the management of ecological and socio-economic systems which are extremely complex and which are much harder to control than any technical systems. To sum up, the distance between the control of technical systems and the management of natural systems is just as great as that between the control of a spaceship and the control of a table spoon. For millions of years living nature developed of its own, and did it very well, until after man had begun to disrupt this mechanism of self-control by invading its natural course of development.

In order to regulate this complex process, it is necessary to understand the essence of such regulations as applied to the economy, ecology and nature in general all of which are so closely interwoven in utilisation of natural resources.

To give practical realisation to this approach to environmental protection, it is necessary to fundamentally change the prevalent practice where industrial development is planned apart from ecological planning. In addition to that, it is this development that pre-determines, in the existing primacy of production, both the volume and structure of nature protection measures in the form of so-called territorial plans for nature conservation.

Besides, the sequence of the different phases of planning is such that it separates the functions of individual economic entities from one another: some of them create ecological problems, whereas others try to resolve them. It goes without saying that neither the poacher, nor the lover of decorative plants who picks huge bouquets of field flowers are the main destroyers of nature, although their actions lead to the destruction of the natural environment. The main culprit is modern resource-intensive, high-waste, contaminating industrial production. And since this is so, we must keep in mind that our concern for nature conservation must begin with improvement of the methods and structure of industrial production. Here, too, special consideration must be given to ecological requirements. Such improvement can be achieved only by getting in place the achievements of science and technology, by changing the structure of social production, by gearing it to final results, i. e. by building up consumption funds while minimising expenditure of natural resources and making ecological restrictions more rigid.

Moreover, the very object of such "management" is the "man-production-nature" system in which man plays the central system-forming factor. The aim of this system is man's wellbeing and the means whereby it is achieved are measures to adjust the environment to the socio-economic and ecological objectives of social development.

This system of controlling the utilisation of natural resources in the USSR is operated by a large number of state bodies ranging from an industrial enterprise to the Supreme Soviet of the USSR. The functions of each one of them are shown in chart No. 1. This book does not examine the legal fundamentals of nature conservation, so we shall only dwell on the organisational and economic aspects of nature protective activities.

Central to the system of control over the utilisation of natural resources is the State Committee for the Protection of Nature (Goskompriroda of the USSR).

The key objectives of this committee are:

to carry out comprehensive system of management aimed at protecting natural resources in the country, to draft and pursue integrated scientific and technological policies for nature protection and for rational utilisation of natural resources, to coordinate the activities of the ministries and government agencies in this field;

to exercise state control over utilisation and conservation of the land, surface and ground water, atmospheric air, plant (including forests) and animal life (including fisheries), over the seas and the natural resources of territorial waters in the USSR, over the continental shelf and the economic zones of the USSR, also over widely occurring minerals;

to draw up and submit to the State Planning Committee proposals on questions concerning nature protection and the rational utilisation of natural resources to be included in the drafts of guidelines for the economic and social development of the USSR, for state five-year plans of the economic and social development of the USSR;

to formulate proposals for modernising the mechanism of the use of nature, to endorse ecological rules and standards for utilisation of natural resources and for protection of the natural environment against pollution and other harmful effects;

to expertise master plans for the development and distribution of industries; to exercise supervision and control over the observance of ecological standards in developing new technology and materials;

to issue permission for storing up industrial, domestic and other waste, for ejecting harmful substances into the environment, for making use of animal resources, for utilising atmospheric air by industrial facilities; for opening up the earth's interior by geologists, for cutting forest in renewable quantities, for using land in all types of economic activity;

to maintain nature preserves and exercise control over hunting, to take stock of wild life, provide information for the Red Data Book of the USSR;

to disseminate information about nature among broad segments of the population, to forster in citizens, and particularly in the youth, a caring attitude towards nature;

to plan and promote cooperation in ecological matters with other countries and with international organisations.

Goskompriroda is also planning to set up under its auspices a council whose members—scientists, public figures, representatives of local councils of people's deputies, industrial leaders—will discuss problems of environmental protection. This council is also expected to work out recommendations for the solution of these problems.

The principal document regularising the procedure of nature conservation in the USSR is the State Plan for the Protection and Rational Utilisation of Natural Resources. The Plan includes three groups of parametres;

1) the limits of permissible pressure upon the natural environment (rates of water consumption, water disposal, ejection of pollutants into the atmosphere, etc.);

2) measures to prevent harmful effects upon the natural environment and for improving utilisation of natural resources (measures to protect water and air, to prevent erosion, to protect forest, measures to make fuller use of mineral resources, etc.);

3) measures to assure sufficient funds for more effective nature conservation.

Practical realisation of all these plans are to be achieved by geological surveying, forest and water industries, by the use of industrial facilities that may have negative effects upon the natural environment. At present some ministries have departments that are responsible for nature protection (the ministries for the coal, chemical, petro-chemical, timber, building materials industries, etc.). Special services for nature protection have been organised at a number of enterprises of the chemical, pulp-and-paper and some other industries.

A special role has been assigned to the system of control over the state of the environment, to ecological monitoring. A network of eco-monitoring stations operates in the Soviet Union which exercise supervision over the quality of water resources. There are hydro-meteorological outposts that measure the concentration of dust and chemicals in the air of 450 cities of the Soviet Union.

However, despite all these organisational measures the ecological situation in most regions of this country is not improving. The reasons for this should be sought in the insufficiency of the economic mechanism of the utilisation of natural resources.

2. The Economy of Nature Utilisation

Earlier in this book we repeatedly emphasised the extensive, cost-prone character of the Soviet economy. This can be judged, among other things, from the fact that the per unit expenditures of natural resources in all sectors based on the utilisation of natural resources are still very high. The main reason for this lies in the imperfection of economic relations between production units, on the one hand, and the state, on the other, over the utilisation of natural resources.

The production process at any factory is linked with the utilisation of natural resources. Such elements of the natural environment as water, vegetative cover, and the air perform a dual function: on the one hand, these elements, being worldly goods (or use values), assure normal life for man as a biological species, and in this way take part in the reproduction of the work force, and, on the other, these elements of the natural environment are the necessary components of production processes and serve as a factor of growth of social production. Today society expends tremendous funds for the reproduction of natural resources. This expenditure tends to grow because of the exhaustion and deterioration of the quality of these resources. However, to this day, their consumption is not properly taken into account in the cost structure of production and in the products made at factories and plants that do not contribute sufficiently to reproduction of natural resources. This can be judged from the following comparison between different payments into the national budget from the profits made by different enterprises. On average about 20-22 per cent of the income is deducted as pay for production assets, whereas the rental payments constitute a mere 3 or 4 per cent. At the same time the production assets of the public sector of the Soviet national economy and all natural resources are in the exclusive possession of the State, which puts them at the disposal of industrial enterprises.

The latter are required to pay for the utilisation of natural resources and for their disruption. Today no such things are done. Therefore the free use of water in agriculture enables Minvodkhoz to almost literally pay ducks and drakes with our rivers.

It appears necessary to introduce a centralised system of payments and fines that will stimulate reduction in the per unit expenditure of natural resources and in the industrial waste that pollutes the natural environment. The said payments must have regional differentials and must be instituted with an eye to the level of technology achieved in different industries. All such pay rates can be integrated into three groups: 1) payment for the utilisation of natural resources; 2) fines to be paid for exceeding the permissible level of environmental pollution; 3) charges into the regional funds for renewing natural resources and for environmental protection. These funds are used for financing all major nature protection activities in a given area, such as the setting up of purifying installations, recultivation of land, reforestation, etc. Fines cannot be planned ahead of time, and as such can be used by regional administrative bodies to serve emergency situation. All the other forms of payment call for a revision of the procedure of distribution of the profits made by industrial establishments. Rates of payment for the utilisation of natural resources and obligatory payments into the budget must be based on the economic assessment of the quality of resources, on the permissible level of environmental contamination calculated from industrial, ecological and sociodemographical prognostication of development in a given territory. The planning of production and reproduction of resources must be based on the general concept of regional nature protection.

To implement regional programmes for the rational utilisation of natural resources and for environmental protection, it is expedient to carry out at least two important organisational procedures: 1) to set up regional bodies that will specialise in regulating the use of natural resources, or councils for the protection of the environment and for the renewal of natural resources, these organisations consisting of the managers of major industrial enterprises, representatives of regional administrative organs, also of scientists and other specialists; 2) to set up a fund that will accumulate money for renewal of environmental resources for which purpose the entries of the debit and credit sides of local budget should be revised.

On the credit side this new article of the regional budget will, on the one hand, reflect the amount of natural resources expended by industrial enterprises in the process of production and their "contribution" to environmental pollution and will, on the other, reflect the technical and economic potential of these industrial enterprises. In certain cases, owing to the faulty system of price formation, and also because of the obsolescent technologies at many enterprises, budget subsidies may well be needed in the form of long-term credits to be repaid as the price structure is improved and an effective resource-saving technology of production is adopted.

Differentiation in payments and charges must, in a way, influence the distribution of industrial facilities by rendering ineffective the construction of pollution discharging plants in heavily urbanised regions or water-intensive operations in areas suffering from a water shortage.

A distinguishing feature of the proposed plan for renewing natural resources is that the entire job of nature conservation comes directly under the control of state and public bodies concerned with the rational utilisation of natural resources on a nation-wide scale, as well as in each region separately.

The edict "On improvement of environmental protection" adopted in January, 1988, provides that in future industrial enterprises will pay, at fixed rates, for the utilisation of natural resources, also for polluting the natural environment. The edict also stipulates that such payments will stimulate the rational and complex utilisation of the land, water, forests, and other natural resources, whereas the money paid as penalties for the discharge of pollutants will be used for measures to prevent any further contamination, considering the specific features of the natural complexes in a given area.

It is not easy to set up an effective mechanism of economic incentive for resource conservation and nature protection. This is no easy job, with the assessment of economic loss from pollution and environmental deterioration being the most difficult of all. This damage is the result of industrial and social losses because of the high sickness rate caused by the contamination of air, water and food, also because of the additional expenditures on capital repairs, partial replacement of fixed production assets and non-production assets due to intensive corrosion. Other sources of this damage are low crop yields, low fish productivity in seas, lakes and rivers, deterioration of forest life, declining recreational value of health resorts and resort sites because of contamination and degradation of the environment. At present the Soviet Union uses several methods of assessment of economic damages from environmental pollution. However, none of them is sufficiently comprehensive or accurate.

According to this author's calculations, in the USSR these damages add up to 30-35 billion roubles a year, with 15-17 billion roubles (or 50 per cent) of the damages) caused by atmospheric pollution; 7-8 billion (20 per cent) comes from contamination of water resources, as much from erosion, also from the disintegration of the structure and pollution of the soil, and 3.0-3.5 billion roubles (or 10 per cent) from noise pollution.

Failure to assess economic damages from environmental pollution entails at least three negative consequences: difficulty in imposing fines upon those responsible for such pollution, the absence of economic incentives to introduce purification technology (when its socio-economic effectiveness is not taken into consideration), and, finally, inadequate distribution of state investments in nature conservation. Let's take a closer look at these two problems. Actually, new methods have been worked out to determine the socio-economic effectiveness of nature conserving measures. These methods consist in counting up the expenditures necessary to prevent pollution and degradation of the environment, and in comparing these expenditures with the possible economic damages that has thus been prevented. However, for our managers and industrial executives the size of the economic damage that has been prevented is an ephemeral category which they do not want to recognise. At the same time the ecological studies carried out by many western researchers and practical workers show that nature protection will recoup all these expenses. Every dollar invested in nature conservation forestalls environmental damage and damage to human health worth several dollars. In socialist society where the wellbeing of people (which is unthinkable without a healthy environment) is the principal objective of its development, nature conservation must be more effective.

The staff of the Central Economico-Mathematical Institute of the Academy of Sciences of the USSR have attempted to size up (in roubles) the overall additional gain that our country could have if ecological and economic parameters were taken into account the way they should. Although this is nothing more than an estimate, the figures it has produced are very impressive.

The economic gain from the lower incidence of disease and from higher labour productivity, given the conditions of optimal parameters of the quality of the natural environment, minus the money expended for these purposes, is somewhere around 15-20 billion roubles a year. Ecological planning offers similar prospects, as it could yield a stable and growing economic gain worth not less than 20 billion roubles from growing agricultural production and fisheries, from harvesting the products of nature, expanding recreation zones, all of which would in the long run save our country the much needed foreign currency, and indeed increase its influx from foreign tourism.

Ignoring the economic damage from environmental disruption leads to serious mistakes in our policy for planning and financing ecological programmes. Of all the other investments in nature conservation, the greatest (about 80 per cent) are in the protection of water and air. Significantly, over the past two decades, the investments in the protection of water resources have been considerably higher than the investments in air protection (See Table 19); in some years and in some periods their proportion was 9:1, and in some industries as high as 10:1.

If we recall the structure of the economic damage from environmental pollution (even if inaccurate) in which the damage from atmospheric pollution is 50 per cent, the above distribution of investments is not optimal by far. Very possibly the existing structure of the damage inflict-

Table 19

Funds Invested in Nature Protection and in Rational Utilisation of Natural Resources (in comparable prices, million roubles)

	1971-1975	1976-1980	1981-1985	1985	1986
Total sum invested in nature protection	7,291	10,824	11,120	2,486	2,615
including:					
protection and rational utilisation of water resources	5,411	8,338	8,087	1,683	1,798
protection of atmospheric air	725	950	899	234	263
Ratio between the two	7.5:1	8.8:1	9.0:1	7.2:1	6.8:1

ed upon the environment is precisely the result of many years of the faulty investment policy.

We must hasten to make a reservation that the above distortions in the make-up of capital investments in nature conservation are not merely the result of the poor economic mechanism of utilisation of natural resources. These mistakes reflect some of the more general negative phenomena characteristic of the Soviet national economy resulting from the prevalent "residual principle": inputs in nature protection measures are made out of the left-overs from the funds at industrial enterprises that are then used for environmental protection. The main reason is that the USSR has no developed specialised division of machine-building industry that would manufacture equipment (particularly purifying facilities) for nature conservation. And this is where the capital-intensive water-protective facilities, with large settlers, collectors, dams, sludge tanks, etc. are given priority over all the others. As for air protection, it requires more sophisticated equipment, installations and instruments which we have not got in sufficient quantities.[1] This also explains the fact that forever underuse capital investments earmarked by the State for nature conservation and for the rational utilisation of natural resources. In 1986, for example, only 78 per cent of the money allocated for the protection of atmospheric air was utilised, and 88 per cent for the protection of water resources.

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[1] This gives rise to paradoxical phenomena such as this: in power engineering which is the worst offender against the air, more than 80

I would like to emphasise again that until we have an effective economic mechanism which would give an economic incentive both to government departments and industrial establishments to conserve natural resources, and to protect the environment, and until we have scientific methods of sizing up natural resources, including the air, also until we learn how to assess economic damage from environmental pollution, how to assess the effectiveness of nature conservation, we shall have to face the fact that resource-saving, and low-waste technologies will remain and will continue to be viewed as a burden on our economy.

Over the past several years, one of the Soviet republics, Estonia, has carried out an experiment in creating a system of economic incentives for nature conservation and for the rational utilisation of natural resources, with a specialised fund of nature protection as one of the links of this system.

The nature protection fund set up by the Ministry for Forestry and Environmental Protection of the Estonian SSR is made up of:

a part of the money exacted from enterprises in compensation for the losses inflicted upon the environment and natural resources of the republic;

a part of the fines for the violation of the legislation on nature protection;

sums obtained from the sale of confiscated property;

a part of the penalties imposed for the loss of mineral wealth over and above permissible quantities.

In addition to that the fund may also be augmented by drawing money from various socio-cultural programmes,

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per cent of the total capital investments for nature conservation has for many years now been channeled into water protection.

Chart № 1

System of Management of Nature Use in the USSR

Managing bodies	Basic functional subsystems				
	laws on the use of nature	standards of the quality of the environment	control over the state of the environment and over the use of nature	national economic planning of nature use	measures to improve nature use
1	2	3	4	5	6
Supreme and local bodies of state power and management					
The Supreme Soviet of the USSR, Supreme Soviets of Union and Autonomous republics	Adoption of laws of the USSR, laws of Union and Autonomous republics			Endorsement of state plans of economic and social development of the USSR, Union and Autonomous republics	
Presidium of the Supreme Soviet of the USSR, Presidiums of the Supreme Soviets of Union and Autonomous republics	Issue of decrees and adoption of edicts				

1	2	3	4	5	6
Council of Ministers of the USSR, councils of ministers of Union and Autonomous republics	Issue of edicts and ordinances			Drafting and submission of short-term and long-term state plans for economic and social development to the Supreme Soviets of the USSR, Union and Autonomous republics	Drafting and implementation of measures to make rational use of natural resources and to protect them, including measures to change the location of industrial facilities, and their reconstruction
State Planning Committee of the USSR (Gosplan)				Working out methods and methodology of planning nature use, also defining priorities in nature conservation	
State Committee for Nature Protection (Goskompriroda)	Drafting of government edicts on nature conservation	Endorsement of quality standards of natural environment	Supervision and control over the quality of natural environment	Ecological examination of national economic plans, new machinery and new technology	Working out strategy of nature conservation for the whole country

1	2	3	4	5	6
State Committee of the USSR for Science and Technology				Planning of research into nature conservation; coordination and financing of research work. Joint (together with the Academy of Sciences of the USSR) prognostication of the state of the environment and resource potential for regions and for the country as a whole	
State Committee of the USSR for Construction (Gosstroi)		Drafting normative documents for planning and building of populated centres, for the building of purifying installations with consideration given to environmental protection			

1	2	3	4	5	6
State Committee of the USSR for Standards (Gosstandart)		Reviewing and endorsing of complexes of state standards for nature conservation			
Industrial ministries and departments				Planning of measures to promote nature conservation that are carried out by enterprises and organisations under relevant ministries and departments	Implementation of nature protection measures that are within the competence of relevant ministries and departments (to recultivate the land, to reduce losses of minerals, to build and exploit purifying installations, to introduce waste-free technologies, etc.)
Enterprises, organisations, offices				Planning of nature protection and rational utilisation of natural resources	Practical realisation of measures of nature conservation

from the fund of state, cooperative and public enterprises and organisations so they can jointly finance operations aimed at protecting the environment and at improving amenities in town and country.

The money of this fund is used to protect the natural environment and utilise natural resources in Estonia in a rational way. It is also funneled into capital investment and overhaul, into maintenance, research and development. A portion of the fund is used for applied research and as bonuses.

The amount of nature conservation work carried out annually and its financing are agreed with the Planning Committee and the Finance Ministry of Estonia. After that the figures are endorsed by the Commission of the Presidium of the Council of Ministers of the Estonian SSR for environmental protection and for the rational utilisation of natural resources.

The money supplied by the fund comes on top of the sums for capital investments provided by the state. Research work is financed in accordance with the agreements concluded by research organisations, including the research divisions at colleges and universities.

Make-up of the nature protection fund

Type of resources	Percentage of deduction into the fund
1	2
I. Forest resources	
1. Sums exacted in compensation for the damage done as the result of the violation of forest legislation (except for the violations in forests that belong to collective farms)	100
2. Fines exacted for violation of forest legislation and of the fire-hazard regulations in forests	100
3. Fines for the violation of rules on utilisation of standing timber	100
4. Funds from the sale of illegally obtained products of the forest (except for the products obtained in the forests of collective farms)	100
II. Hunting resources	
1. Sums exacted for damage through the illegal hunting of wild animals and forest fauna	50

Type of resources	Percentage of deduction into the fund
1	2
2. Fines for violation of hunting rules	50
3. Money from the sale of illegally hunted game, also from the sale of the hunting weapons when the law-breaker has not been found	50
4. Money from the sale of hunting weapons confiscated by legal authorities, also from illegally obtained pelts of wild animals	100
III. Water resources	
1. Sums obtained in compensation for the damages from infringement of water legislation	70
2. Sums exacted from organisations and enterprises, from foreign physical and juridical persons in compensation for damages they have caused by polluting internal sea and territorial waters in areas adjacent to the territory of the republic	99
3. Fines imposed for the infringement of water legislation	70
IV. Fish resources	
1. Sums exacted for compensation of damage inflicted upon fish population through pollution	100
2. Sums exacted for compensation of damage through illegal catching or through the destruction of precious varieties of fish and other kinds of marine life:	
from enterprises and organisations	100
from private citizens	70
3. Fines imposed for violating fishing rules and for the violating regulations on the protection of fish stocks and on supervision of fishing in fish-breeding reservoirs:	
by administrative authorities	70
by legal authorities	50
4. Sums from the sale of:	
the fish confiscated from enterprises and organisations, also the fishing gear and boats confiscated from private citizens	100
the fish confiscated from private citizens, also the fish when the law-breaker has not been found	70
boats and fishing gear confiscated by legal authorities	50

Fines for breaking nature conservation laws are imposed by the administrative commissions of district Soviets and by city Soviets of people's deputies. In cases specified by the law such fines can be imposed by special nature conservation bodies and by courts. The protocols sent to the administrative commissions of city and district executive committees for imposition of so-called administrative penalties bear the mark "for nature protection funds" stamped by nature conservation bodies, the address of the bank and the corresponding bank account.

The organisations doing work with the money of the fund inform the Estonian Ministry for the Forests about the progress it makes within the agreed time limits.

Upon the completion of this work or other activities carried out with the money of the fund, the officials of the ministry which has carried out the work, and the agency responsible for the protection of the relevant natural resource, draw up a report to this effect. A copy of the report is then sent out to all the relevant organisations.

Every year, not later than March 1, the Forestry Ministry files an account of expenditures of the fund with the Commission of the Presidium of the Council of Ministers of Estonia for the Environmental Protection and for the Rational Utilisation of Natural Resources, and with the Finance Ministry of Estonia.

3. Bureaucracy—The Enemy of Nature

In order to develop a theoretical basis for effectively resisting the bureaucracy, one must clearly understand its essence, the mechanism of its emergence and development in the conditions of socialism, and then analyse the material, social and political foundations on which it develops, and indeed flourishes and penetrates into all spheres of public life, including the economy as a whole, and into the system of utilisation of natural resources. The bureaucracy is not merely a paperwork style of management, not merely a command method of administration, and not simply a callous officialdom at all levels. These, however, are merely the outward features of bureaucracy. In actual fact, the bureaucracy is not simply an antipode, but the most bitter enemy of democracy and self-management. Article 2 of the Constitution of the USSR says: "All power in the USSR belongs to the people. The people exercise state power through Soviets of people's deputies, which constitute the political foundation of the USSR. All other state bodies are under the control of, and accountable to, the Soviets of people's deputies."

That is what the Constitution says. Actually things are quite different. The evolution of the various forms of management in the USSR has led to a situation in which real economic power is now in the hands of the executive bodies of the state: the Council of Ministers of the USSR, the ministries and departments of union, union-republican and republican competence, and government departments. How could such a metamorphosis take place? A close analysis of the evolution of state management gives enough reason to consider that this metamorphosis comes from the deformation of property relations in our society. The same Constitution of the USSR says, in its Article 10, that "The foundation of the economic system of the USSR is socialist ownership of the means of production in the form of state property (belonging to all the people), and collective farm-and-cooperative property." It is precisely this foundation that was loosened and undermined. At a plenary meeting of the Central Committee of the CPSU, in January 1987, Mikhail Gorbachev gave an exhaustive evaluation of the abnormal situation that had taken shape in our country. This is what he said: "Special mention should be made of socialist property. The control of who is really in charge of it, and how, has seriously weakened. Socialist property has often been eroded by parochialism and departmentalism. Gradually a situation has emerged where socialist property no longer belongs to anybody. Property no longer 'costs' anything, it has no real owner either, and has in many cases been used for extracting unearned income."

This very stern but fair evaluation applies primarily to our principal national wealth — the natural resources. Article 11 of the Constitution reads: "The land, its minerals, waters, and forests are the exclusive property of the state." Several generations of Russian revolutionaries rose up against the Russian autocracy precisely for that. The Decree on Land was the first decree issued by the Soviet government. Thousands of heroes of the Civil War lost their lives fighting for the land and for freedom. So how could it have happened that the basis of the economic system of the country — socialist property — no longer serves our society directly? The reason for this sad circumstance is the emergence, rapid diffusion and subsequent consolidation of the sectoral, departmental, bureaucratic methods of administration of social and economic development of the country. People's power exercised through the Soviets of people's deputies, was gradually being replaced by the power of ministries and departments. The departmental bureaucratic apparatus has expanded tremendously; its numerous bodies, like metastases, have spread throughout the living body of the public and economic life of the country and have subjected it to their departmental and in many ways mercenary interests. The scale of this evil can be judged from the following facts.

Upon its formation the USSR had ten Union people's commissariats. In 1936 their number was 18, in 1956—52, and in 1979—64 ministries of all-Union competence. In later years ministries merged and then fell apart, in order to merge again and again. As a result, there are fifty-five ministries of all-Union competence in Moscow, and also some other multi-sectoral committees. If we add to that the state bodies for the administration of all the other spheres of public life, this figure would rise to a whopping 115 all-Union government departments. On the average every Soviet republic has 30 ministries, 15 state committees and 20 other departments of republican competence. Very significant in this respect is the structure of these administrative jungles. Of the total administrative personnel of 18 million executives and managers, 67 per cent are in the apparatus of sectoral ministries and departments down to its lower echelons; 13 per cent constitutes the apparatus of the Soviets (which does not include the elected representatives of Soviets of people's deputies, but includes only the apparatus of the presidiums of the Supreme Soviets of the Union, of Union and Autonomous republics and the executive committees of Soviets of people's deputies at all levels); 20 per cent constitutes the apparatus of courts, of judicial, cooperative and public organisations.

This is only the upper echelon of bureaucracy. If we take the entire administrative pyramid, its sprawling magnificence is even more fantastic. In 1986 the Soviet Union had about 650,000 independent administrative bodies (state administration, economic and social affairs). This means that each administrative body controlled about four enterprises or organisations.

The combined staff of all administrative bodies was 32.6 million, which made it a mere 2.5 workers and engineers per administrator. However, these average figures concealed much more serious "deformations" in our domestic policy. For example, in industry and on state farms the proportion was one official to 1.5 workers and engineers, whereas in construction industry the figure was still lower.

Yet it was not this depressingly large bureaucratic personnel that eroded public property. The fact is that it had passed out of the hands of its true masters — the Soviets of people's deputies — into the hands of the ministries and departments. It is these bureaucratic bodies that over the years have become the actual masters of public property in defiance of the interests of society and the state, spokesman of these interests.

This tragic shift of power took place because the Council of Ministers of the USSR, which is, under the Constitution, both the executive and administrative body of state authority (Article 128), is vested with the right to decide all questions of state authority (Article 131). The Council of Ministers of the USSR, backed by the system of ministries and departments, runs the national economy, works out short-term and long-term plans for economic and social development and takes measures for their implementation.

According to the current bureaucratic system, the ministries and departments are entitled to control financial and material resources (capital investments, production assets and raw materials). As a result, all these resources, which de jure belong to "all the people", to the whole nation, have actually become the property of ministries and departments which run them as their full masters, at their discretion and in their own narrowly departmental interests.

Formally such departments ask for more and more resources in order to boost the performance of the industries under their authority, and each one of them thinks that its industry is the most important, or may be among the most important in the national economy. This idea is kept going by the artificially created acute shortage of goods that practically all of our industries manufacture. Every ministry is sure to receive the necessary funds from the national budget without recompense because it knows full well that it is firmly backed by the state plan for increasing production the realisation of which is binding on all enterprises in the country. This is a strong argument and it works unfailingly, because none of the organisations that distribute these resources can openly come out against the state plan. What a supplying agency can do at best is to cut down the amount of resources requested by the ministry, resources which are perennually in short supply, but it cannot turn down this request altogether. The heads of the ministerial departments and the authors of the bureaucratic sectoral plans, who know very well the techniques of drawing up economic plans, maximalise these requests for resources, quite justly believing that a part of the resources requested would be cut down anyway. Most of the resources are "wangled" by those of the ministries and departments which promise the most, especially those that succeed in ramming a decision through the Central Committee of the CPSU and the Council of Ministers of the USSR on speeding up and expanding the development of their respective industries. Much assistance in this struggle for obtaining free natural resources by sectoral departments comes from relevant sectoral subdivisions in the State Planning Committee of the USSR, at the Council of Ministers of the USSR and at the Central Committee of the CPSU.

The tighter the like-minded officials of different departments close ranks, the more chance they have of success. To get a sweeping plan through means larger investments, more material resources, more workers, greater the wage funds and bonus allocations, also more foreign currency, greater prestige and benefits. Thus public and national interests are replaced by departmental and personal mercenary interests.

Moreover, the Soviets of people's deputies which do not directly take part in production, have no access to natural resources, and are thus deprived of real economic power. What is more, the Soviets become dependent on the ministries and departments which control resources and are therefore full masters not only in their respective industries, but indeed in all parts of the country where they conduct their economic activity. Hence the so-called residual principle of allocation of funds for the solution of key social and ecological problems.

In this case departmental, highly bureaucratic activity manifests itself as a monopolistic force which is equally hostile to society and the state.

Here are several examples. Our country needs to increase food production. To resolve this priority task the Soviet government adopted a special food programme. So how is this task being resolved, or rather how the numerous government departments do their best to block it? The first superdepartment is Minvodkhoz which employs more than two million workers, including 350,000 leading executives. The senior members of Minvodkhoz and some titular representatives of the branch science are exerting maximum efforts to convince the public and the superior governing bodies that without wide-scale irrigation and soil amelioration the food programme will never be implemented. This position is being championed by their sympathisers — officials at the State Planning Committee of the USSR, at the Council of Ministers of the USSR, also at the Central Committee of the CPSU who are in charge of soil amelioration in the country.

Those of the scientists and other specialists who are trying to prove the futility of wasting billions of roubles of the taxpayers' money and who show the irremediable damage being inflicted upon nature and the national economy by extensive irrigation, by soil salination, swampling and flooding, by squandering water resources and by dangerous pollution are forced into silence with all kinds of demagogical statements that they want to "scuttle the food programme adopted at the May (1982) Plenum of the Central Committee of the Communist Party". This demagoguery is used to cover up some truly mind-boggling practices. One such example is the construction of the useless and harmful Volga-Chograi canal which will cost the nation two billion roubles. This construction project was the brainchild of Minvodkhoz as an element of the much touted broader plan for redirecting part of the flow of some northern rivers and turn it to the south. The idea of this project is to syphon 1.9 cu km of water from the Volga and direct it into a canal 353 km long, its entire earthen course unprotected against seepage. As is known the Central Committee of the CPSU and the Council of Ministers of the USSR issued an ordinance that cancelled this wasteful project. Nevertheless, Minvodkhoz jockeyed it through a multitude of bureaucratic channels clearing the way for its construction. Significantly, the construction work on the Volga-Chograi canal was at its various stages opposed to by State Planning Committee, by the Ministry of the Fisheries, also by the Academy of Sciences, the regional executive committee of the Astrakhan Soviet of People's Deputies. The

Soviet press also carried many articles critical of this project. In October of 1988, a special joint commission of experts from the Academy of Sciences of the USSR and the All-Union Academy of Agricultural Sciences was set up to examine the project. The commission included hydrologists, geologists, soil specialists, ichthyologists and economists who visited the building site, heard out local specialists, and, after exhaustively studying the project, came to the conclusion that the building of the Volga-Chograi canal was ecologically dangerous and economically unsound. The commission established that the hardships that had afflicted Kalmykia, with its loss of cattle due to lack of fodder, with increasing salinisation of land and its desertification, was the result of mismanagement and not water shortage. The true reason for this depredation was the thoughtless growth of the cattle population with no consideration given to such factors as fodder productivity of local pastures, and the poor supply of feed. Other factors were overploughing which had led to a sharp decrease in natural grazing areas, pollution and depletion of surface and ground waters because of their predatory exploitation, expansion of irrigated crop-growing with no consideration for specific local soil hydrological features. This predatory exploitation of soil and water resources has for a long time been papered over with figure padding and statistical distortions, which was finally exposed by the People's Control Committee of Kalmykia.

The building of the canal will not solve either ecological, or economic, or social problems of the region, but will, instead, aggravate them. Kalmykia will inevitably suffer from secondary soil salination, the rise of highly mineralised ground water, and this will lead to shrinking of natural pastures and to further desertification. Considering the present-day sanitary-epidemiological situation one can assume that the area along the future canal will favour an outbreak of plague and tularemia. The quality of water in the planned canals will be below standard, and its utilisation for irrigation will inevitably affect the quality of farm produce due to the accumulations of nitrates, pesticides and other harmful substances. This project does not attempt to solve the problem of utilisation and diversion of drainage water. The canal creates a very real danger of destruction of the precious sturgeon, and will have a negative effect on other commercial varieties of fish in the lower reaches of the Volga and in the northern Caspian and will push the European population of the saiga antilope to the brink of extinction.

However, in spite of the commission's findings and conclusions, the top bureaucrats of Minvodkhoz and their patrons decided that the construction work on the canal must not stop and that what the poject needed was only partial adjustment.

No partial adjustment will correct the initially built-in faulty solutions based on the "cost-intensive principle" rather than the principle of final results. Surprisingly, Minvodkhoz bulldozes through decisions in defiance of public opinion, or the opinion of scientists, regardless of the existence of possible alternatives to these decisions. In the case of the Volga-Chograi canal the ministry had its way despite its clearly narrowly departmental approach which conflicts with the long-term interests of the entire Caspian region.

The Volga-Chograi canal flies in the face of the cardinal policy of the Soviet state for intensification of social production, a policy aimed at saving natural resources, at increasing returns, at nature conservation. The Volga-Chograi project does not meet any of these requirements. The building of the canal which is already underway must be stopped immediately.

However, while Minvodkhoz still exists, alongside its patrons at the State Planning Committee (Gosplan) and other policy-making bodies, the building of the Volga-Chograi canal will go on. Actually the building of canals is just one side of this water gamble. This departmental octopus has tremendous resources. Suffice it to say that every year it receives 10 billion roubles from the government. The Volga-Chograi canal is just one episode in this saga of waste of people's money. This is why, in addition to this project, many more useless and even harmful canals are being built that link up the Volga and the Don, the Dnieper and the Danube, the River Ob with the River Karasuk. Also plans are under way for linking the Volga and the Ural, and some other extravagant and ecologically harmful building projects.

But how truly effective are all these "heroic" efforts that the leaders of Minvodkhoz are taking for the people's money? Actually their effect is almost nil. It is true that in some areas of the country the rainfall is scanty and drought is a frequent occurrence. This is why harvests fluctuate from one year to another in the steppes. For example, the relationship between the maximal and minimal grain yield has over the past twenty years been 5:1 in the Volgograd region, 3.5:1 in Kazakhstan, and 3:1 in the Stavropol region. But can these undesirable fluctuations be put down only to bad weather, and can irrigation provide enough guarantees that no drought would ever ruin the crop? Of course, not. In every climatic zone different farming methods should be used.

The Djenibek agro-forest farm in the eastern part of the Volgograd region in the drylands of the trans-Volga area has been in existence for more than 50 years. For decades this farm has tested different methods of grain growing on solonchak soils which are adequately cultivated in the shade of the afforestation belts. In any weather, at all times, even in the severest drought, the local farm fields yield no less than 20 centners of high-grade hard varieties of wheat per hectare at minimal expense. Meanwhile with the massive irrigation of lands in the Volga region and on the Don the yield of cereal crops remains very low. For example, in the Rostov region the average annual grain harvest in the 11th five-year plan period was 25 per cent lower than that in the 10th five-year plan period. The fields cultivated in accordance with so-called "intensive" (or high-cost) technology yield a mere 6-7 centners of grain per hectare. On irrigated fields the crop yield is half as high as planned and does not exceed the crop yield on rain-fed lands. Another example: 40 per cent of farms that raise maize on irrigated farmlands take in 15 centners per hectare whereas the best farms in the same climatic zone that take in 62 centners use no irrigation. The cost of grain production is skyrocketing. In 1970 it was 3.2 roubles on the average for the whole country, and in 1986 it was 9 roubles per centner. Grain farming, once highly profitable, has begun running at a loss.

In the Volga area and in the Caspian steppes where Minvodkhoz has over the past three five-year plan periods expended tens of billions of roubles and where the irrigated area has been expanded nine times over to a total of 4.5 million hectares, the gross volume of farm produce over ten years (1976-1985) increased by 1.5 per cent in the Kuibyshev region, by 2.8 per cent in the Saratov region, whereas in the Volgograd region the productivity of local farms dropped by 7 per cent. As for grain production it went down 9 per cent in the Saratov region and 16 per cent in the Volgograd region. Why is it that the situation is so disastrous in spite of the radiant promises made by Minvodkhoz executives? This is how local specialists assess this situation. The chief agronomist of the collective farm named after Karl Marx of the Balakovo district of the Saratov region (*Sovetskaya Rossia*, January 14, 1988) said: "I have been working as an agronomist for 20 years. In the past we collected some 110-130 thousand centners of grain on the average. But a few years ago our harvests began to fall off. There are many reasons for it. But the main reason is the outsize area of the irrigated field we work on: 4,500 hectares. This is six tenths of the total arable land at our collective farm. These irrigation systems were built in the days of the amelioration 'boom', and were done in a hurry. Such systems were not of the best kind either. Upon its completion the project turned out to be a network of open canals (a total of 220 km). About half the area of the irrigated fields has since been swamped and salinated. In the old days when we worked our land without irrigation, it accumulated lots of nutrients. Weeds were removed on the fallows over an area of up to 1,200 ha. This practice was fully justified, for the fallows were truly the land of gold, because they yielded up to 50 per cent of all the grain on the farm. It was strictly forbidden to leave the land fallow when irrigation was applied." I think that the judgment of the experienced agronomist needs no comment. Significantly, the total area under irrigation in the Saratov region is around 500,000 hectares.

It is important to know how Minvodkhoz prevails upon state and collective farmers to use irrigation where there is no particular need for it. On February 21, 1988, the newspaper *Pravda* published an interview with the chairman of the Rossia collective farm of the Pugachev district of that region. In it he retold his conversation with a representative of Minvodkhoz. The latter demanded that the collective farm chairman sign a report on an allegedly completed job of soil amelioration on a collective farm field whereas no such job had been done at all. The chairman also said that a specially formed ministerial commission had flown in by helicopter for the same purpose. Incidentally one hour of helicopter idle time costs about 400 roubles. Apparently showmanship has become so much part of their character that a whole team of ministerial executives set out on an expensive trip to procure a barefaced lie.

Typically enough, these representatives of the ministry demanded that the collective farm chairman give them a fictitious report to relay to the 27th Party Congress.

The question is why the "soil ameliorators" propose the kind of work that they know they will never be able to do? Who drew up these bogus plans and later demanded that they be carried out, if only on paper, in a fictitious report. In our days, too (this was alarmingly referred to in our press, notably in *Pravda*) certain ministries and government departments give enterprises assignments but fail to back it up with machinery and materials. By doing so they deprive these collectives of the flexibility that is stipulated in the Law on State Enterprises. What is it but deliberate upward distortion, which holds back the progress of perestroika?

In reply to the just criticism of Minvodkhoz over the very low effect of irrigation and amelioration, its executives usually admit that by itself soil amelioration has done almost nothing for grain growing (and this admittedly is the basis of agricultural production). At the same time they claim that the ministry has largely contributed to the production of fodder for livestock. Let's set the record straight and see if this is really so. Some 11.5 million hectares of irrigated and ameliorated land have been allotted for fodder crops. This, it is true, has increased fodder production in some areas of the country. However, from the economic point of view this increase brings more harm than good. According to Academician V. Tikhonov the production of one ton of fodder on irrigated lands in the European part of the Russian Federation costs an average of 958 roubles. The production of one ton of meat in live weight on such feed costs 8,200 roubles, which is three times as much as on the feed obtained on rain-fed lands. Reckoned in terms of commodity meat this is 16 roubles per kilogram, not counting the overheads. I think that any reader will understand how ruinous such meat production is for both the state and family budgets.

Could fodder production do without these heavy expenditures? Of course, it could. On the Kuibyshev collective farm in the Kuibyshev region, a team under N. Marzhanov which operates on a contractual basis, has now for several years been taking in 70 centners of cheap fodder per hectare of rain-fed land, whereas farmers go to greater expense in money and labour to take in an average of 50 centners of fodder from one hectare of irrigated land in that district. For some reason this does not concern Minvodkhoz whose main objective is to spend as much of what it has wangled from the state as possible. Regrettably the local party organisations have an exactly the same approach. In the Volgograd region, for example, it was originally planned to irrigate 160,000 hectares. However, the leaders of the regional committee of the Communist Party and its first secretary Kalashnikov, who had shortly before headed the Minvodkhoz of the Russian Federation, thought it insufficient and demanded that the irrigated area be expanded to 250,000 hectares, in spite of the fact that the irrigated lands here yielded a mere 35 centners of fodder per hectare (as against the 70 centners produced without irrigation). This is a bureaucratic view of "acceleration" by means of the traditional cost-boosting mechanism.

But Minvodkhoz is not the only institution that displays such concern for the Food Programme. Referring to the need to implement this programme, other departments, too, do their best to obtain funds from the government, and demand lucrative orders. Listen to the arguments of the senior members of the administrative and scientific staff executives of the ministry of Mineral Fertilisers, and you will hear exactly the same thing. They insist, among other things, that the food programme cannot be implemented without increasing the production of mineral fertilizers and pesticides. This ministry, incidentally, also has its allies in the person of ranking officials at the central planning and governing bodies. This is why this ministry, too, receives many billions of roubles, material resources and costly equipment, some of which is bought for hard currency. Since the early 1970s production of mineral resources in this country has grown 2.8 times to a monstrous 36.2 million tons, which is 70 per cent more than the amount of mineral fertilizers produced in the United States. Nitrates and phosphates have contaminated water bodies, also agricultural produce, especially vegetables. This has sharply worsened the quality of water, and the general ecology of water bodies, has reduced its fish productivity, has inflicted serious damage upon recreation areas, agricultural produce and the health of the population. The dramatism of the situation is also heightened by the fact that with the growing production and utilisation of artificial fertilizers, costs rather than crop yields rise. Many farms have over the past several years increased their expenditures on mineral fertilizers fivefold. At present 20 per cent of the collective farms run at a loss, and more than half have a profitability of up to 25 per cent, which is not sufficient for their normal extended reproduction.

In these conditions it is absolutely necessary to stop expanding the production of solid fertilizers and at the same time to concentrate on raising their quality, on making their application more effective. Of course, to do more is not always the same as to do better. Quantity is not always quality. It is only porridge that cannot be spoiled with butter, as the Russian saying goes, and that only if you know how much butter to put in. As for chemicals, their excessive use is sure to spoil both the soil and the harvest. This happened in the past, and this is happening today. But why should this practice go on? The scientists of the Biology Institute of the Bashkirian branch of the Academy of Sciences of the USSR have conducted the following experiment. For five years they applied 30 per cent less nitric fertilizers on sugar beet plantations than the prescribed norm, but did that in optimal combinations with other fertilizers. What happened then? The crop yield of the tubers grew by 30 per cent, and the yield of sugar increased by six and even nine centners per hectare compared with that of control crop fields.

According to scientists, the nitric additives could well be used in smaller amounts. All that is necessary is to carefully select high-yielding plants that would have a slow metabolism. There is still another aspect of this problem: what happens to the fertilizer in the field, in the soil? Fertilizers that are thinly spread over the surface are washed off by rain and blown off by wind. This shows that fertilizers must literally be introduced, and not dispersed. Very typical in this respect is the experience of some foreign countries. The *Echo* potato-planting machine manufactured by a Finnish firm and used in Estonia was fitted with a special contraption that put the fertilizer directly into the hollow, together with the planting tuber. The firm guarantees, provided the operation instructions are followed, a crop yield of 300 centners of potatoes per hectare with half as much fertiliser as the prescribed norm. Importantly, this technology not only assures the use of less fertilizer but also prevents it being washed off the soil and protects the environment from being polluted with it.

Special mention should be made of the quality of produce. Intensive use of fertilizers, especially nitric fertilizers, leads to the deterioration of crop quality. This means that the proportion of proteins, sugar and vitamins in seeds, fruits and tubers—all that we value so much in vegetable foods—goes down. At the same time toxic substances accumulate in overfertilized plants, especially in vegetables.

In spite of all these restrictions the Ministry of Fertilizers is trying to expand in every way the production of mineral fertilizers regardless of expense, also regardless of disintegration and contamination of the environment, social and ecological losses for people. A glaring example of this is the persistence with which relevant organisations are expanding the extraction of phosphorites in the Estonian SSR. The Ministry of Fertilizers got the Central Committee of the CPSU and the Council of Ministers of the USSR to adopt a decision to build an ore mine at Kabala, the Rakvere district which, I must say, is by far the best agricultural area of the republic. In 1986 it produced 218 million roubles worth of agricultural produce, which is ten times more than the profit we expect from the production of phosphorites. And since the ministry is planning to build here a mine with ten shafts 6 m in diameter and 100 m deep each, the miners will have to pump out 240,000 cu m of ground water a day. The depression thus formed will syphon off the water within the radius of 50 km and will bring down the water level in the water wells of this area by 20 m. As a result, the farmland will be desiccated and become barren. The mine is expected to operate for 40 years and then close down, whereas the land is here to stay forever. However, the timeservers at the Ministry of Fertilizers do not want to reckon with the facts of reality. All they mind is how best to carry out the bureaucratic production plans and how to spend the people's money. Nor do they reckon with the fact that by doing so they destroy the lifestyle of local residents, putting their future at risk. The thing is that the phosphorites are covered with black shales. When covered with earth these shales are not dangerous, but when they are extracted and exposed to the air they react violently with oxygen and rain water and may easily catch fire in spontaneous combustion. This makes shale a source of three types of pollution. The first source of such pollution is combustion itself at the temperature of 800° C. This seat of fire might be very deep under the earth's surface but nevertheless, it heats up the soil and kills the vegetative cover. Second, the atmosphere gets polluted with sulphur dioxide and carbon dioxide in critical volumes. And third, oxygen renders heavy metals, including radioactive metals, soluble, and lixiviated. Eventually they enter the perpetual circulatory movement of water which, as is well known, also passes through the human organism.

Some smart scientists, such as M. Pevzner and B. Naumov, who apparently tried hard to get on the good side of their bosses, came to a Solomonic compromise and suggested that the black shales be buried. They even succeeded in getting the silver medal of the National Exhibition of Economic Achievement of the USSR for their invention. However, the black shales thus buried in the previously developed site are just as easily subject to spontaneous combustion. Suffice it to say that in an area called Maardu, near Tallinn, scientists have recorded 19 such seats of spontaneous combustion at temperatures ranging between 50 and 170° C. The ministry seems to be reluctant to reckon with the fact that Estonia has no work force that could extract phosphorites, and that the collective and state farms of the republic do not need any more mineral fertilizers.

Incidentally, the other regions of the country do not need these solid minerals either, considering the existing way of production and application. The point is that the level of phosphate contamination of soil and water is too high as it is. The free aluminium and iron enter into chemical reactions with the residual phosphorus, thus binding it in salts which plants cannot assimilate and which are indeed harmful to them. This leads to the destruction of the soil structure, the microflora and humus, which in turn reduces the productivity of farm crops. It has been established that the amount of residual phosphorus, which is a dangerous contaminant of the soil — ranges somewhere between 21 and 33 kg per hectare of ploughland. The Ministry of Mineral Fertilizers is trying to compensate for the declining fertility of the soil by introducing more chemicals into it, which can well be compared to a shot of stimulant for an exhausted athlete. This should never be allowed to happen. We need a drastic improvement in the quality of fertilizers that will match precisely the different types of soil. The fertilizers must be packaged in a way that will rule out loss in transportation and in storage, and in this way eliminate additional environmental pollution. And this task is much more complicated than the extensive build-up of new production capacities. All these problems have to be resolved anyway. You can't hoodwink nature.

A still more acute situation has been created by the same ministry and its blood brother the ministry responsible for the chemical industry, resulting from the growing output of pesticides. Earlier on we spoke about their almost indiscriminate application and about its spurious effectiveness. Not being satisfied enough with the growing production of domestic pesticides the fertilizers ministry has decided to import equipment and technology for the production of bazudin, a terrible poison whose toxic effect is as great as that of a combat toxic weapon. The ministry shelled out a whopping 350 million roubles. The reason the ministry gave was the same: to help implement the Food Programme. The ministry decided to build the facilities for the production of this toxic substance in Krasnoarmeiski district of Volgograd, a city with a population of one million.

The regional party committee and the executive committee of the city Soviet took up the case in superior organisations trying to prove that the new chemical facilities would aggravate the already grave situation in the city, especially in the Krasnoarmeiski district. And they had every reason for it. This is how the Volgograd medical institute summed up the ecological situation there: "For every 1,000 new born babies 70.3 have pathological deviations from the norm as compared to 44.2 in control areas. Intestinal infection is on the rise — an increase of 110 per cent. So is conjunctivitis — 350 per cent, and inflammation of the ear — 220 per cent, skin allergies and dermatoses — 100 per cent." A government commission set up to study the situation "considers it inexpedient to produce bazudin at the Volgograd factories Caustic and Khimprom. It is also impracticable to place new production facilities into service before the implementation of nature protection measures in accordance with the earlier decisions, and before the general ecological situation has improved. The resources thus saved should be directed at the implementation of the national programme for nature conservation."

But the ministry is still holding out. At a public meeting in Volgograd, a spokesman for the Ministry of Mineral Fertilizers said that the new production facilities had 137 purifying installations. His words were greeted with jeers, because everybody knew that the 1986-87 plan for the construction of installations for nature conservation at the Caustic factory had been fulfilled by 26.8 per cent, and only one tenth of construction targets for the first three months of 1988 were met. The city is seething — public meetings and demonstrations, posters, letters of protest to the central organs of the country. These documents bear the signatures of thousands of people, whereas the ministry is concerned with just one thing: fulfillment of the bureaucratic plan of its own creation.

When you listen to officials at the Ministry of Farm Machine-Building you may get the impression that they are trying just as hard to fulfil the Food Programme. Come to think of it — 600,000 tractors a year, which is five times as many as in the United States. And what tractors! All of them are power-intensive, or in a simpler language, heavy-duty machines that pack the top soil and destroy its structure. And that many of these machines have no market does not seem to bother the ministry. After all the money and other resources for their production the ministry receives from the state budget. As for the financial losses that the manufacturers of these giants inevitably incur, these are covered by the profits made by and taken away from work collectives that turn in better performance. Soviet farmers are in dire need of spare parts for their machines, of missing trailed or mounted implements for the complex mechanisation of farming and livestock breeding. They also lack ecologically safe machines for boardless ploughing, for the minimal cultivation of land by way of joint, combined operations, for planting and tending field-protective afforestation belts. Instead of satisfying all these vital needs the ministry guided by departmental ambitions launches the building of another giant tractor plant in the town of Yelabuga in Tataria. Luckily, the Soviet government, under pressure of public opinion, decreed that the projected tractor plant was to be converted to a car plant.

Another department that is growing just as rapidly is the ministry responsible for the production of medical preparations. Its top executives and accommodating sectoral research organisations are convinced and are trying to convince others that without their products, notably artificial protein for livestock breeding, all attempts to fulfil the Food Programme will fail. At one of the conferences on biotechnology, Minister V. Bykov said that there were no alternatives to the production of protein-vitamin concentrates obtained from petroparaffins. Naive as it may sound, the officials at this ministry put the following ingenious interpretation upon the fact that the advanced capitalist countries do not produce protein-vitamin concentrates: the United States produces a lot of soya protein which it supplies to all the other advanced countries, whereas we have not got enough of it. The question is: why don't we produce soya in such areas as Moldavia, or the Ukraine, or Kuban, or Transcaucasia, or the Soviet Far East? Incidentally, we have for many decades had even an all-Union research institute for the production of soya beans. But why necessarily soya? We have other leguminous plants growing in this country with a high concentration of protein such as peas, beans and lupine. And aren't there other sources of proteins, amino acids and vitamins such as clover and alfalfa which, besides, restore the structure of the soil and enrich it with nitrogen and organic substances? And why should we give up on our water meadows and dry grassland, and hay harvests that have for centuries supplied our livestock with high-value fodder, which is a perfectly balanced natural feed, harmless to animals and cheap to produce?

All that, however, is not within the terms of reference of that ministry. It even does not want to hear about scaling down the production of these chemical feeds, and continues to build industrial facilities that are harmful to both nature and human health. An example of this are the recent accidents in Kirishi, a town near Leningrad. However, the Kirishi plant is not the only one of its kind in the country. Altogether there are seven such plants already in operation, with several more being either on the drawing board or already under construction. So again precedence is given to ministerial plans over anything else.

But what is Gosagroprom[1] doing in this case, you may wonder. Alas, Gosagroprom is just another bureaucratic department with the same objectives and methods of work as any other government ministry. Instead of organising the work directed at intensification and ecologisation of agriculture, Gosagroprom fully supports the activities of the above allied departments in hopes of creating a material base for effective development of the agrarian sector of the Soviet economy. What is more, Gosagroprom not only sanctions their activity, but also stimulates it with the growing number of orders for their products, because instead of reducing the outsize farm fields and cattle population, it is planning to increase them still further.

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[1] Liquidated in 1989. Its functions now are performed by local agricultural bodies-*Ed.*

By its very nature the bureaucratic apparatus, separated from production processes as it is, cannot behave in any other way. The command-style of running affairs is the only style that it knows. In his work *The State and Revolution* Lenin writes that bureaucrats are divorced from the masses, that they are privileged individuals that have placed themselves above the masses. We can see that everywhere in our country today. Here are a few examples. Hundreds of thousands of people are engaged in bureaucratic management at the central, republican, regional and district divisions of Gosagroprom. Gosagroprom officials give instructions as to what crop to sow, when, how and how much to do it, also how many head of cattle to keep, what to feed them and how. Each regional Agroprom has some 30 or even 40 departments employing altogether between 400 and 600 people. Particularly bloated is personnel of the district Agroprom divisions. All attempts at reducing this overblown bureaucratic organisation have failed. Here is another example. There are only eight collective farms in the Ulety district of the Chita Region. The local Agroprom "apparat" has a staff of 530 men. The annual estimate of its expenditures is 1,670,000 roubles. The one and only staff reduction produced the following results: some of the employees thus affected were moved from one place to another, and the total wages fund was thus reduced by a mere 2.1 per cent. What does this raft of officials do all day long? Primarily paperwork, telephone conversations and endless office meetings. The management of the Frunze collective farm in the Belgorod region say that they are summoned to regional and district organisations of Agroprom some 40 and even 50 times every month. You may wonder why? Naturally not for their own pleasure. All these rendezvous are arranged for issuing numerous instructions and orders...

The real value of all these instructions can be judged from the following example. The Caspian area is in the grip of an ecological crisis. On the so-called "black lands" of Kalmykia, which until not so long ago were excellent pastures, more than 600,000 hectares are loose sands freely blowing in the wind, in other words: desert. The Caspian Sea is badly contaminated, and in some adjoining regions the air is so heavy with dust that there is nothing to breathe... So what will the ecological situation be like in the near future there? What practical steps should be taken to protect the environment of that vast region? In the first place it is necessary to reduce the livestock population, mainly sheep, which is four times as large as the local sheep-walk permits. Overgrazing in Kalmykia has led to hundreds of thousands of sheep starving to death. Yet Gosagroprom does not allow the local authorities to reduce the livestock population. At times the situation is almost absurd. Local farms receive large sums of insurance money from the state compensating the loss of sheep. What is more, these farms are ordered to buy more sheep instead of spending this money for upgrading pastures, organising normal supply of water for the animals, for the development of agro-forestry, etc.

This vicious practice continues under pressure from the local party officials responsible for agriculture. Here is another typical illustration. The situation in the eastern areas of the Rostov region, adjacent to Kalmykia, is almost as critical. The stock-breeders of the Remontnensk district requested the regional party committee the permission to cut the sheep population and at the same time to improve its quality, make it more productive so as to protect pastures and eventually to obtain more meat and other products. So what was the response to this very sound proposal? The secretary of the regional party committee V. Gubski demanded that the district have, by early 1988, 400,000 sheep, and not one head fewer. To remove any misunderstanding the party secretary repeated his favourite: "There must be no breaking of ranks on the point."

This is the command style of management from which we all suffer so much, a clear case of a boss forcing his will upon those below him in rank. It is clear, though, that no commands, no orders can help solve the many problems of our agriculture. What is necessary is to consult people, to take their interests into consideration, to reckon with their experience. Such a bossy attitude stifles initiative and blocks progress.

Gubski is not an isolated case. All the people like him care about is the so-called state plan. As for the conservation and reproduction of natural potential, the observance of ecological requirements, this seems to be the least of their concern.

But we have many departments and we have many tasks to tackle in different sectors of the economy. And, of course, each one of these departments thinks that its problems are the most important and the most urgent ones. And it sure is not so easy to understand that the most important task of increasing the production of power, the task that the USSR Minenergo has been trying to accomplish so strenuously is a self-inflated problem. Actually, this problem does not exist except as the product of energy mismanagement. It is nothing short of criminal to try to resolve the energy problem at any price, not excluding the price of the loss of precious natural resources, and the price of disruption of the way of life of thousands upon thousands of people.

Meanwhile Minenergo speculates on the artificially created shortage of energy and acts precisely in this direction. Here are some facts. The construction of the Daugavpils Hydro in Latvia which has flooded vast areas of precious grasslands and pastures; the construction of nuclear power stations in the Crimea and on the River Belaya in the Krasnodar region at the risk of destruction of the national and world-famous health resorts and the unique Kuban black earth, the famous Russian chernozioms; a project for a new hydro-electric station on the River Katun which would flood the ancient historical monuments in the area and would force the Altai native population out of their homeland; plans that Minvodkhoz and Minenergo are trying to push through for setting up a cascade of hydro-electric stations with vast storage lakes on the Greater Ussurka River in the Soviet Far East which would destroy the precious biospheric nature preserve, the only one of its kind in the region of Sikhote

Alin. The authors of this project do not find it disturbing at all that the project provides for cutting 40,000 hectares of unique cedar pine for the sake of just one hydro-electric station. Nor are they perturbed that the ensuing floods would cover the so far poorly explored ore-bearing areas and that, according to geologists, the area is dissected by numerous fault lines in the Earth's crust. These facts have put in doubt the whole idea of building storage lakes for the simple reason that they may not be able to hold the water for any length of time. However, none of these facts seem to stop the activity of the leaders of Minenergo. Even the fact that 84 per cent of the work Minenergo surveyors did in 1986 and 100 per cent of its work in 1987 was pronounced defective.

The ministry has lately proposed to the government that 100 major hydro-electric stations be built over the coming twenty years, including stations on flatlands with very large storage lakes. It looks like Minenergo is out to start another deluge for the good of the people, and in the name of the people.

Being generously endowed by the state budget with the people's money, Minenergo can easily afford to build other, not necessarily power engineering, huge and expensive projects. A few years ago taking into account the already difficult ecological situation in Leningrad a proposal was put forward for the building of 30 transport interchanges in the streets of the city in order to cut the especially harmful exhaust near traffic lights. The project required 90 million roubles but the Leningrad City Soviet had no such money. At the same time Minenergo easily scared up a billion roubles to build an economically ruinous and ecologically dangerous dam across the Gulf of Finland which is under construction to this day in spite of the protests of the scientific community of the country.

The picture is as clear as it is upsetting. Here again notorious departmental interests are put before the interests of the nation. Earlier on we mentioned the merciless chopping down of cedar pine groves in Siberia. This brings to mind the activities of still another ministry: the

Ministry of Timber Industry, or Minlesprom. In a sense this ministry has no peer in that no other organisation has done so much to perpetrate such large-scale rapacious destruction of forests as Minlesprom. We have already said, our country stores up the greatest amount of wood in the world, which Minlesprom claims full credit for. To set the record straight such indiscriminate tree cutting is a crime because it destroys the principal wealth of our country, forest, and disrupts the irreplaceable ecological ecosystem — land-forest-water.

Minlesprom is engaged not only in forest cutting. It uses the timber (the most valuable of all) as the material for making wood pulp and then turns it into paper. Strangely enough, the ministry chops down enormous amounts of timber and produces very little paper. For per capita production of paper the Soviet Union holds 40th place in the world. This is how the head of this ministry, M. Busygin, interpreted this situation, as quoted in the *Argumenti i fakti* weekly in February 1988: "The Soviet Union has inherited from Czarist Russia an almost half a century lag in this sphere as compared to Europe. We had to start practically from scratch in order to build our pulp-and-paper industry." Incidentally, in the same article the minister noted that many machines built early in this century were still used in the timber-cutting and pulp-and-paper industry. His explanation is odd, indeed. For back in 1965, we were told that the idea of restoring ministries was to pursue a single centralised policy based on the achievements of science and technology.

That was his explanation. But what is happening in actual fact? According to the minister, a mere five per cent of existing paper mills meet modern world standards, 48 per cent meet the technical standards of this country, and 47 per cent need replacement. This in large part is the result of the bureaucratic management of scientific and technical progress. But there are other reasons, too. We have come to a point where the reader will have to brace himself for another sensation. None of our numerous machine-building ministries manufacture special boiling machines of continuous action, complex lines for processing scrap paper. Nor do they build purifying installations for pulp-and-paper mills. The results of this apology for scientific and technological policy are that out of the existing 150 mills only one-third have purifying installations. Unbelievable, but it's a fact.

Some ministry! It chops down a lot of forest, makes little paper and heavily pollutes the environment. And for all that it selects unique nature zones. One such area is Lake Baikal which the ministry is intending to contaminate with wastes from a local pulp-and-paper mill, in fact has been doing so for a number of years in defiance of the strongly worded decisions of the Central Committee of the Communist Party and the Council of Ministers of the USSR on the protection of this unique lake. The situation is aggravated by the fact that this mill may be converted to other operations only by the end of 1993, according to the long-term plans of the ministry.

Another no less unique site that Minlesprom has taken on is the Jurmala resort area in Latvia. Here on the lovely shore of the Gulf of Riga the Sloka pulp-and-paper mill is busy meeting its production targets. Actually the production programme of the mill is not very high: some 70,000 tons of paper, which is about 1.1 per cent of the total output of paper in the Soviet Union. But even this very modest production programme has proved to be sufficient to bring this unique resort area to the brink of full ecological disaster.

In April 1988, I, as the head of the ecologico-economic section of the Scientific Council of the Academy of Sciences of the USSR dealing with the problems of the biosphere, took part in an extramural session of this council. Taking part in its work were representatives of the Minlesprom of the USSR, the Minlesprom of the Latvian SSR, the Academy of Sciences of the Latvian SSR, the leaders of the party organisations and the Soviets of Jurmala and the Sloka pulp-and-paper mill. The session brought out different approaches to the solution of the problem of the resort area. The residents of Jurmala and the scientific community of Riga itself proved it necessary to take urgent and radical measures to save the health resort from ecological disaster and, in concrete terms, demanded that the pulp-and-paper mill be closed down for good. There were many reasons for this action. The effluent from the mill had created an oxygen-less dead zone five kilometers long in the River Lielupe. Both in summer and winter the total lack of oxygen extends down to the very mouth of the river. Even in the water of the Gulf, several kilometers from the coast oxygen deficiency persists all year round. The content of lignosulphonates is 600-700 times as great in the river and 60 times as great in the sea as their normal background concentration. Industrial effluent, especially within ten kilometers below the paper mill, causes serious bacterial contamination: coli-index is 1,000 times higher than the standard. All the other microbiological indicators are also highly unsatisfactory. In addition to that the water contains microorganisms that can cause serious infectious diseases in people. The poisonous discharge from the mill into the atmosphere kills pines on the dunes, trees that not only adorn the coasts of the Baltic Sea but are an important source of fresh air in the entire resort area. A typical response to this sad statistics came from Dankfelds, the head of the technical department of this mill. He gave a sound dressing down to those "non-specialists" in whose opinion the "purified effluent" was "slops" and the cellulose waste material was nothing but "poison". These people, continued this "expert", "do not know that cellulose is a polysaccharide, the most widespread organic substance in nature". That was what the whole discussion amounted to.

As for the leaders of the union and republican Minlesproms, these "responsible" people were so much concerned with the "task of meeting the planned targets" that they did not bother to go into the details of the problem, but merely adopted decisions and gave instructions. Their arguments were as brilliant as they were simple. Since the country holds 40th place in the world in per capita production of paper the Sloka plant will continue to work as it has worked all these years. After all it provides 1.1 per cent of all paper in the country!

The question suggests itself: who if not the administrative apparatus in this industry had reduced the country to this pitiable 40th place, and why is it that health resorts must pay for all this with the health of holiday-makers? Is all this in the interests of the nation?

The nation's third largest health resort which in summertime accommodates more than 250,000 holiday-makers daily are perennually threatened by ecological disaster: the River Lielupe below the paper mill is contaminated to the utmost, and in hot weather the water gets covered with a heavy pall of pathogenic bacteria. Isn't this a paradoxical situation that the wellbeing of the whole of Jurmala is firmly in the hands of the management of the mill?

To allay public anxiety, the authorities again and again promise to install better technology and reduce pollution. Easier said than done. The reconstruction of the Sloka pulp-and-paper mill has, over the past several years, eaten up forty million roubles of the tax-payer's money. Out of this sum thirteen million roubles have been spent on the construction of purifying installations. But the mill still continues to contaminate the health resort. Recently Minister Busygin issued Order No. 106 "On normalisation of the ecological situation at the Sloka pulp-and-paper mill and in the adjacent districts of the resort town of Jurmala in 1988-1995". The order contained dozens of clauses and hundreds of paragraphs with a host of instructions. About the most important of these instructions, No. 22, says: "The design institute Giprobum, the All-Union Scientific and Production Amalgamation VNPObumprom, the Ministry of Woodprocessing and Paper Production of the Latvian SSR, and the Sloka pulp-and-paper mill have been authorised to make technical and economic calculations for fundamentally improving the ecological situation in the area adjacent to the plant with a view to setting up ecologically harmless operations and combining its activity with the needs of the resort town of Jurmala. Upon completion this document is to be presented to the Ministry prior to September 1, 1991". So, this is how it goes: measures have been mapped out, tens of millions of roubles of the nation's money has been allocated, and instructions issued. Now we can quietly wait for four years. The last paragraph of the instructions sounds particularly impressive: "Verification of the fulfilment of the said decisions in this order is to be placed upon the minister's deputies comrades Guskov and Chuiko." As you see, the ministry outlines the types of work that have to be carried out, it also provides the finances for their realisation and controls its own activities.

Meanwhile the unique health resort is being slowly but surely contaminated. It does not even have the 1.5 million roubles for modernising the purifying installations in order to detoxify the noxious domestic wastes.[1]

I think that the best postscript to this episode in the ecological history of our country would be Lenin's words: "Socialism cannot be decreed from above. Its spirit rejects the mechanical bureaucratic approach; living, creative socialism is the product of the masses themselves".[2]

4. People Versus Nature Killers

> The CPSU believes that at the present stage the strategic line of development of the political system of Soviet society consists in advancing Soviet democracy and increasingly promoting socialist self-government by the people on the basis of active and effective participation of working people, their collectives and organisations in decision-making concerning the affairs of state and society.
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> From the Programme of the Communist Party of the Soviet Union

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[1] As a result of ministerial dillydallying and procrastination the sea beaches were closed to bathers throughout the whole of the summer of 1988.

[2] V. I. Lenin, "Meeting of the All-Russia Central Executive Committee. November 4(17), 1917", *Collected Works*, Vol. 26, 1977, p. 289.

The need for the people's self-government is not just a slogan, or a call. This necessity is quite objective because it stems from the very goal of social and economic development under socialism. In Lenin's definition this goal is to achieve the highest possible living standard, the free and full development of all members of society. It is quite natural to assume that the people and society itself, and each one of its members, more than anybody else, is interested in raising their wellbeing. And since this is so, it is the people who must govern social and economic life in such a way that they can achieve this fundamental objective. Self-government of the people is not an invention of politicians or scholars. It has deep historical roots. The basis of the people's self-government has always been a collective decision, and not some sort of arbitrary action taken by one individual. Self-government has nothing in common with a command or an order coming from above. Large and small groups of people have always sought to resolve their important problems together, in friendly cooperation with one another. They held family councils, or called meetings of the whole rural community or of a work team.

In Russia people's self-government as the democratic form of running the affairs was practised at national level. Such, for example, was the practice of republican rule in Ancient Novgorod where back in 1136 the local prince could not rule without the will of the popular meeting, or *Veche*. I would like to point out here that Soviet official history writers, accidentally or by design, insisted that the *Veche* represented only the feudal oligarchy and voiced only their interests. In actual fact the *Veche* gave access to active political and public life and to self-government for broad sections of not only the free people of Great Novgorod, but also those of neighbouring villages. Specifically, the interests of the rural population were defended by free citizens who formed urban communities.

Of course there were, at different times, people and circumstances that blocked this form of solving important problems with other forms of government based on command, diktat and coercion. Nevertheless, people sought to achieve self-government, to resolve their vital problems.

But in our technocratic age we cannot imagine being well off and happy without the preservation of the natural environment. People not only understand this, but also feel it in their daily life, their work, at home, and in the way they feel. There is nothing accidental about the fact that among the different forms of social movement that have come to life in the process of democratisation of our society, the most active of all is the movement for nature conservation, for the protection of a wholesome habitat. Taking part in this movement are masses of people from all walks of life who are both very active and dedicated to this noble cause. Already in its early stages this movement has proved very effective.

Come to think of it, the All-Russia Nature Conservation Society has been in existence for many years, and similar societies have been set up in all other Union republics. At all Soviets of people's deputies standing commissions have been organised specifically for nature protection. Similar departments have been set up at the Gosplan of the USSR and the Gosplans of the Union republics, and that aside from numerous nature protection units, departments and other bureaucratic bodies of a higher rank. However, in spite of all this the natural environment is getting more and more polluted, whereas the ecological situation is getting worse and worse. But the public movement in defence of nature is another matter. Whatever has been done to prevent the baneful effects of pollution upon nature, upon the human habitat, is the result of the active intervention of the public only. It is true that very little has been done so far. Actually all that is just precedents, although even these precedents augur well for the future. Their main significance is that they occurred without any support from official bureaucratic nature protection bodies, without any ministries and government departments, indeed in spite of their blatant opposition. I shall cite some of the precedents.

1. By dint of tremendous efforts the public succeeded in turning down the disastrous projects for redirecting the flow of northern and Siberian rivers to the southern areas of the country. Had these projects been implemented, vast areas both in the north and the south would have suffered greatly from the wanton destruction of the natural environment, of the economy and culture.

I singled out this episode, which I call "the great battle", not only because of the especially tragic consequences of this project, but also because it was planned at the height of the period of stagnation. I shall give a nutshell description of the main phases of this "battle". As the head of the ecological-economic section the author of this book succeeded in holding an extended (I would call it historic) session of the Bureau of the Scientific Council of the Academy of Sciences of the USSR. The holding of this meeting was facilitated by the Chairman of the Council, Academician N. Fedorenko and the deputy chairman of this council, Corresponding Member of the Academy of Sciences N. Petrakov. Taking part were also the chief engineer of the project for the redirection of the flow of the northern rivers A. Berezner, the chief engineer of the project for the redirection of the flow of the Siberian rivers, I. Gerardi, and many others of their colleagues, assistants and representatives of allied organisations. The meeting was held on June 7-8, 1983. I presented my report entitled "Substantiation of the Socio-economic Effectiveness of the Inter-basin Redistribution of Water Resources". In this report and in the discussion that followed many participants in the session revealed the economic and ecological unsoundness of the projects for inter-basin redistribution of the river flow based on the misconception of the growing shortage of water resources in the southern regions of the country. They also showed that the difficulties in water supply arise not from the physical insufficiency of water resources, or from their uneven distribution throughout the different areas of the country, but from their extensive, prodigal utilisation, from their squandering that does both the economy and ecology more harm than good. I would like to call the readers' attention to the absurdity of the very idea of the authors of these two projects: to even out the distribution of the waters on the territory of the Soviet Union. It was proved with abundant clarity that any such attempts should be abandoned for the foreseeable future. This discussion pursued a very well-intentioned, though modest, objective. Since the engineers who authored these mammoth projects of water rotation are not either economists or ecologists and just could not know of possible economic, social and ecological effects of such vast operations, we decided to provide them with this missing information in order to fill in the gap which was bound to emerge in any narrow specialisation.

But the response to our objections was very strange, to say the least.

The authors of the projects and the engineers who had been invited to the conference walked out in a huff, saying that their activities were being blocked. To make sure that in the future scientists would not again feel like "blocking the work of experts" the authors of the projects and their patrons from Minvodkhoz of the USSR and from even higher departments succeeded in pushing the project through the Plenum of the Central Committee of the CPSU in October 1984. Surprisingly, although the decisions of the Plenum did not specify this task which was only once cursorily mentioned in the report on the work of the Central Committee of the CPSU, that was quite sufficient to speed up the job of rerouting the flow of the northern and Siberian rivers to the south. Thus tens of millions of roubles began to leak out of the nation's budget into the sands of bureaucratic waste at redoubled speed.

Any mentioning in the media about the projects was stifled as an attempt to divulge the state secret about the future prospects for the development of the forces of production in the country. It is true that this prohibition was very one-sided, to say the least. For example the media were not allowed to *oppose* the project but they were allowed to speak out *in favour* of it. The opponents were silent when N. Vassiliev, the Minister of Minvodkhoz wrote articles which were printed in whopping editions of millions of copies. In June 1985, for example, the *Sobesednik* weekly (No.23) carried an article which read in part: "The October Plenum of the Central Committee of the Communist Party approved the plan for the realisation of the first phase of the diversion of a part of the flow of the northern rivers and lakes into the basin of the Volga at the rate of 5.8 cu km a year within the framework of the programme for the development of soil amelioration. It was planned to direct some of the water from the Volga into the basins of the Don, Kuban and Terek. Plans are afoot to set up a water-management complex involving the construction of a Danube — Dnieper canal. Work will soon be completed on plans for the building of a canal which will direct Siberian water into the Transurals and Central Asia." Vassiliev was echoed by V. Loginov, Minister of Minvodkhoz of the Russian Federation. In an article "The Waters of the North Will Flow to the South" published in the newspaper *Trud* on August 29, 1985, he sought to prove the importance of this project as beneficial to people.

The diversion of the river flow was part of the Guidelines for the Economic and Social Development of the USSR in 1986-1990 and for the Period Ending in 2000.

However, the envigorating spirit of perestroika, the programme of reforms which was adopted at the plenary meeting of the Central Committee of the CPSU (in April 1985), had begun to bear fruit. A special authoritative commission of scientists was set up under the auspices of the Academy of Sciences of the USSR, chaired by Academician A. Yanshin. I was one of the members of this commission all of whom volunteered for the job with great enthusiasm and with no regard for the great amount of time and effort they spent on their work. A glimmer of glasnost, or openness, raised new hopes. On December 20, 1985, the newspaper *Sovetskaya Rossia* carried an article I had written shortly before. Entitled "Against the

Stream" that article had a massive response from readers. The mail of those days contained a letter signed by some outstanding Russian writers and scientists, V. Astafiev, V. Belov, Yu. Bondarev, S. Zalygin, L. Leonov, D. Likhachev, V. Rasputin who fervently supported the position set forth in my article about the tremendous harm that the proposed diversion of the river flow would cause. That letter, which played an important role in the struggle against such diversion, was also published in the newspaper *Sovetskaya Rossia* on January 3, 1986. The Yanshin commission prepared well-substantiated reports for the Political Bureau of the Central Committee of the CPSU, the Council of Ministers of the USSR and the Council of Ministers of the RSFSR. The report broke the ice of silence and indifference. Reason and common sense took the upper hand. The project for starting the job of diverting the river flow in a southerly direction was withdrawn from the Guidelines by the Resolutions of the 27th Congress of the Communist Party of the USSR. On August 14, 1986 the CC of the CPSU and the Council of Ministers of the USSR adopted the momentous resolution "On stopping the work to divert a part of the flow of the northern and Siberian rivers". That was a hard-won and a very important victory in the struggle against bureaucracy and departmentalism. I must add here that this victory was far from complete. Minvodkhoz of the USSR and its associates in the policy-making bodies changed their tactics but did not abandon the old strategy which is destructive of the natural environment and is based on the cost-intensive approach and braking mechanism.

2. The Soviet public has scored many important victories in the crucial directions of the struggle for nature conservation. I shall name but a few that I consider most important. In October 1986 the pressure of public opinion in this country forced the closure of the pulp-and-paper mill at the town of Priozersk on Lake Ladoga. Its operation so harmful to the natural environment and to human health was stopped because any further dumping of unpurified industrial effluent threatened not only Priozersk and its surroundings but indeed the whole of Lake La-

doga with irreversible consequences. The matter was all the more crucial because the population of many towns and rural and industrial communities, including Leningrad with its population of five million, depend on Lake Ladoga for their water supply.

Such "production" activity led to the degeneration of Lake Drozdovo which was turned into a filthy swamp. But this is not the end of it, for lots of industrial waste seeps through Lake Drozdovo into Ladoga. Moreover, the industrial effluent seeping out of Drozdovo into Ladoga is even more toxic than the effluent coming directly from the mill. Things came to a point when the village of Storozhevoye outside Priozersk, on the shores of Europe's largest water reservoir, could no longer use its water and its population had to bring it in from elsewhere. But Minlesprom has not laid down arms, and is insisting that the mill resume its work. It is trying to enlist support wherever it can, because His Majesty the Plan for the production of paper "is in jeopardy".

3. The capital of Bashkiria, Ufa, with a population of over a million, concentrates over 400 industrial enterprises. Every year they eject into the environment a total of several thousand tons of highly toxic hydrocarbons, chloric, sulphurous and nitric compounds, phenols, ammonia, toluol and other pollutants, a total of about 200 names. The city is polluted to the utmost, especially its Ordjonikidze district. That was the subject of a letter to the newspaper *Pravda* signed by more than 3,000 Ufa residents. They noted that such a situation had been unknown before. About fifty years ago, they say, a plant which was not so big by modern standards and which used carbon hydrates alone, was built about twenty kilometres from the city. Today even industrial facilities that use highly toxic chemicals as a prime material to be synthesised in later stages are often built within the city limits. For example, the Ministry responsible for the production of fertilizers has started the building of a big polycarbonates plant well inside the city limits. Next on the line is a complex for the production of chemical fiber. Significant and even eloquent are the arguments which

government departments use for siting these contaminating and chemically harmful facilities. A visiting ministerial executive who met the builders of the future plant on the building site, admonished: "You have to hurry. Otherwise they will change their minds, just as they did with that river diversion business. The more millions of roubles we plough into the land, the less chances there will be that anyone will ever dare to stop us."

That was the last straw. The residents of Ufa were so incensed that their anger soon spilled over into the press and TV studios where round-table discussions, with Party and industrial authorities taking part. This could be viewed as some sort of emergency, or, more correctly, as a serious and responsible approach to the solution of this burning issue. However, there is still one thing that many of us cannot understand. Why is it that all these representatives of government ministries and departments kept saying that there was absolutely no reason for worry. For example, Vladimir Lapikov, head of the department of hydrometeorology and control over the natural environment, said in the face of the facts that the ecological situation in Ufa had stabilised. The chairman of the state planning committee of Bashkiria, I. Mironenko, broadly hinted that the chemico-phobia comes from poor knowledge of what is going on. To back his words, he resorted to what he called "the impartial language of figures", saying that of the industrial establishments built here over the past five years, only 5 per cent are chemical plants. However, his "language of figures" could not convince anyone. For even the said 5 per cent which he said were chemical plants are as damaging to the ecology, indeed even more damaging, as the remaining 95 per cent of industrial facilities in the area.

The Ufa residents organised a public meeting outside the city Soviet and demanded a ban on the construction of the polycarbonate plant in Ufa and better control over the state of the environment. It became quite clear that all attempts to dodge an open, timely and honest discussion of urgent issues, to turn a deaf ear to the interests of the population of Ufa were doomed.

There were some outrages, too, including acts of hooliganism. It is easy to see that these occur only where the just demands of people come up against the solid wall of resistance put up by the bureaucratic apparatus which fights tooth and nail against anything that might prejudice the interests of the government ministries. They do that oblivious of the interests of society and the nation.

But common sense has again emerged the winner. A special commission of the Council of Ministers of the USSR came out in support, at a meeting with Ufa residents in December 1987, of the decision of the Ufa City Soviet of People's Deputies to move out of town the building site of the plant for the production of polycarbonates.

4. The vigorous actions taken by scientists, writers, artists and workers in culture, and all ecologically-minded citizens brought about important changes in the production plan of the chemical complex in Shchokino which almost ruined Yasnaya Polyana, the world-famous country home of Lev Tolstoy which, after his death, was turned into a museum. Their concerted actions also suspended the building of a factory for the production of pesticides in Tarusa on the River Oka, which put at risk the entire area around the home of the great Russian painter Polenov, also a museum. The people of Shchelykovo where the great Russian playwright Alexander Ostrovsky lived and died, and where his home and his grave are a national shrine, have put up a real fight against the ministerial attempts to build the second section of the Zavolzhski chemical plant.

5. Similarly, the people of Riga, with the active support of the Muscovites, scored a major victory in their struggle against Minenergo which for many years had been pressing its demands for the construction of the Daugavpils Hydro. Had the Ministry had its way, the project would have flooded vast areas of fertile land both in Latvia and in neighbouring Lithuania. Taking part in this movement against this industrial project were school children who collected tens of thousands of signatures under a petition demanding its rejection. Finally the

committee of experts of the State Committee for Construction abandoned this project as economically unsound and ecologically harmful.

This fact brings to mind the active role played by children in the solution of two global problems of our time: the struggle for peace and the protection of the natural environment. Taking part in the stirring movement "Children for Peace" are both Soviet and American school children. The two week visit by the Soviet school girl Katya Lycheva to the United States did a lot more to dismantle the "enemy image" than many years of diplomatic work by experienced professionals. Also considerable is the contribution of children to nature conservation. The children's organisation called the Forest Patrol has been in existence for seventy years. Over this long period the organisation has done a great many good things in the study and protection of the natural environment of our country. We are used to hearing the formula "children are our future," which has a very profound meaning. We say that not only because children will grow up and will eventually take our place in industry and farming, in laboratories and ministerial offices. The future is determined not by age, but by the level of thinking.

Children are our future because they will not want to divert northern rivers and desiccate southern seas. They are our future because they will seek to achieve harmony between nature and society, because they will have a caring attitude to the wealth of our native land. They will preserve peace which is the indispensable condition for the preservation of nature.

6. The Krasnodar branch of the geographical society of the USSR has alerted the scientific community against an economically unsound and ecologically dangerous project, the construction of the Krasnodar nuclear power station on the River Belaya. The committee set up for this purpose included geographers, geologists, soil specialists, biologists, medical workers, engineers and economists. The committee not only proved the great harm that this project would do in the North Caucasus, and the far-

reaching ecological, social and economic consequences of this building project which is being unfolded by Minenergo with active support from the former leaders of the Krasnodar regional committee of the Communist Party, but also put forward alternative proposals for the utilisation of other sources of energy in that region. The documents were directed to the Political Bureau of the Central Committee of the CPSU, the Committee of People's Control, to the Council of Ministers of the USSR and to the Krasnodar Regional Soviet of People's Deputies. As a result, in January 1988, the Council of Ministers, "in view of the high seismicity of the zone selected for this project, and the insufficiency of information on the full range of problems of its design and construction", decided to suspend building work on the River Belaya.

7. In February 1988 type-written notices appeared in the street cars of Nizhni Tagil, inviting its residents to a public meeting. A few days later thousands of people assembled to protest against the ecologically harmful discharge coming from the local iron-and-steel plant which accounted for 92 per cent of the pollution in the city. To make it clear what this mass pollution really means we shall add that this mass breaks down to 1.5 tons for every dweller of Nizhni Tagil. The participants in the meeting demanded that the operation of obsolescent and polluting plant must be suspended. The leaders of the Ministry of the Iron-and-Steel Industry promised that they would do it starting with 1984. However, obedient to the dictates of His Majesty the Ministerial Plan, they kept putting off the fulfilment of their promises "for later". However, now, under the pressure of public opinion, and for the benefit of both man and nature, one of the coking batteries, the worst offender against the ecology of the city, was stopped. The residents of Nizhni Tagil breathed a sigh of relief.

I have cited some pointed examples to show that the natural environment can be and is actually protected by different social forces and different sections of the population. Actually this is the best guarantee of making the ecological situation more healthy, of creating harmony between man and nature. However, to achieve still better results such activities need better organisation, for spontaneous, accidental and episodic actions do not go very far. In other words, the existing popular movement in defence of nature needs a strong organisational basis. Such a basis could, in my view, be provided by the Soviets of People's Deputies, the only genuine foundation of people's power in the country. The enthusiasm of the broad sections of the population is a fine manifestation of the great concern that the general public shows for the wellbeing of individual citizens and for the good of the country as a whole. Everybody must understand that to protect nature is to protect our homeland. Of course, we must be realists. Enthusiasm is very helpful and necessary, but this is not enough, because it usually faces the well-entrenched bureaucracy made up of indifferent officials who relegate things like culture, nature conservation, the spiritual life of society, and moral integrity to the background of the hierarchy of human values.

The Russian social writer Ivan Vassiliev, winner of the Lenin Prize in literature, put this idea in these courageous and beautiful words: "The situation that is taking shape in our society is very alarming—the colossal army of eighteen and a half million desks and chairs which at first faltered under mounting pressure from the awakening masses is about to start a counter-offensive..." This counter-offensive can be reversed only by the active self-government of the people based on the increasingly active role played by Soviets at all levels, and primarily local Soviets, which have to be the full masters of all natural resources on their territory as defined by the Constitution. It is the Soviets that can realise the truly democratic principles of state government that Lenin spoke about. The actual results here depend on how fast a particular body of state power can overcome the existing disparity between the powers guaranteed for the Soviets by the Constitution and the realisation of such guarantees in practice. This applies chiefly to nature conservation, rational utilisation of resources, to the ecological and social environment. So far the Soviets have not been per-forming these important functions satisfactorily. One of the reasons for it is the fact that over decades their deputies were elected primarily on the basis of the "proper" political and social record: party and industrial leaders, men and women known for their outstanding performance in industry and farming, etc. Those were not always people who could stand up for the interests and ecological needs of their constituents.

Most of the deputies to local Soviets were representatives of government ministries. Here is an example of how it happened. We spoke above about the stormy passions in Ufa over its environmental problems. An analysis of these events revealed not only the utter passivity of the executive committees of the Soviets of both the republic and its capital to this legitimate movement in support of the people's demands, but indeed their opposition to this movement. The reasons for this surprisingly odd behaviour are simple. The head of the territorial petrochemical association M. Kukovitsky is at the same time chairman of the commission for nature protection and rational utilisation of natural resources under the Supreme Soviet of the Bashkir Autonomous republic. The corresponding standing commission in the city Soviet is headed by ... the chief technologist of that same association, V. Rakitski. The situation is clear as day. However, it is typical of other Soviets, too. All of us—voters and deputies—have yet to understand that very many of the existing stereotypes of people's government do not accord with the democratic processes in our society.

There is hardly any need to invent anything new. All that the constituents should do is to make better use of their constitutional rights, whereas the local party bodies should lead the initiative in this important work within the framework of the Soviets, instead of backing the ministries and their departments. This accords with the Programme of the CPSU which says in part: "The Party makes sure that the principles of socialist self-government by the people are consistently applied in the administration of society and the state, that is, that the work of administration is not only carried out in the interests of working people but also becomes naturally, and to an ever greater extent, a direct concern of working people themselves, who, to use Lenin's words, know no authority except the authority of their own unity."[1]

Democratisation, openness, criticism and self-criticism, accountability for the current work done, and the responsibility of deputies for their activity, the right of constituents to recall those of the deputies who have failed to perform their functions properly, control over the work of executive and other bodies, broad participation of citizens in running the affairs are the Party programme demands which are waiting to be realised in practical terms.

Speaking of the active participation of people in nature conservation we would like to emphasise its close links with the protection of monuments of the history and culture in our country. Regrettably, the far-flung system of departmentalism have broken up and torn apart what is indivisible and cannot be regarded otherwise, such concepts as *homeland, natural environment, history and culture*. It has been assumed for no valid reason that some departments must protect nature, other departments must protect our cultural heritage and still others must study history. The classics of Marxism warned against this artificial parcellation of our lives. For example, Frederick Engels wrote to George Lamplugh in 1893 that nature and history were two components of the environment we live in, act and realise our potential.

The disruption of this indivisibility inevitably leads to the destruction of its constituent parts. There is nothing accidental about the fact that the monstrous destruction of our traditions, our culture and the very style of life proceeded amidst calls in the late 1920s for banning history, or banishing it from schools and universities. Hence the vandalism against cultural monuments, also the acts of outrage against nature itself, its so-called "fundamental transformation", seemed perfectly justified. All that was done under the slogan "we cannot wait for favours from nature, it is our task to take its wealth". A direct corollary of this policy is the abuse and the physical destruction of many celebrated naturalists and social scientists, such as Vavilov and Chayanov.

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[1] *The Programme of the Communist Party of the Soviet Union*. A New Edition, Novosti Press Agency Publishing House, Moscow, 1984, p. 49.

We have to cite these grim examples because such an attitude to history is not only a thing of the past. The woman journalist Ye. Losoto who has made quite a reputation for cheap and self-inflated sensations, wrote an article which appeared in *Komsomolskaya Pravda.* That was in May 1987, not the remote 1920s. In this article she tried to bring home to young readers that "dragging behind us from the old days is the dusty tail of a country which is forging ahead and which only recently was made up of almost completely illiterate peasants who for centuries believed in God and the Czar and who for centuries blamed the Devil and infidels for all the evils that plagued their existence".

I feel uncomfortable arguing with people who make statements as shameless as that. Instead, let's listen to a discussion between renowned intellectuals, Russian thinkers, about the past of our country which Losoto hates so much. The nineteenth-century philosopher P. Ya. Chaadayev, wrote in his famous "Philosophical Letter" which was published in a journal called *Telescope*: "One of the saddest features of our inimitable civilisation is that we are only beginning to discover great truths which in other places have long since become known and even boring, even among nations who are in many ways far behind us. This comes from the fact that we have never marched hand in hand with other nations: we do not identify with any of the great families of the human race; we belong neither to the West, nor to the East, and we have no traditions from either of them. Cut off from the rest of mankind, we developed outside the mainstream of time."[1] And this is how the great poet A. S. Pushkin promptly responded to this judgment. "Russia with her boundless expanses engulfed the Tatar-

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[1] P. Ya. Chaadayev, *Articles and Letters,* Moscow, Sovremennik, 1987 (in Russian).

Mongol onslaught. The Tatars did not dare cross our western frontiers so as to leave us deep in the rear. They retreated back to their deserts, and the Christian civilisation was saved. As for the allegation concerning our historical worthlessness, I decidedly refuse to accept that... Although I personally am wholeheartedly attached to the Sovereign, I am not at all enchanted by everything I see around me: as a man of letters I am irritated, and as a man of prejudice I am insulted. However, *I swear on my honour that I would never think of exchanging my homeland for another, or having a history other than the history of our ancestors, the history God gave us."* [1]

It follows undeniably from Pushkin's great judgment that Russia need not accept the traditions of either East or West. Can the present judges of her destinies, like Ye. Losoto and her supporters, understand that? I am afraid not.

Contempt for our historical past leads to the destruction of nature, whereas such destruction is inevitably followed by the destruction of monuments of the history and culture of our people. If that monstrous project to divert northern rivers over the southern watershed of the European part of the country had ever gone through, they would among other things have flooded or at least badly damaged 368 out of the 429 ancient monuments of the Russian people and many other peoples of the north-western part of the country. Admittedly, only a tiny proportion of the actually existing ancient historical monuments are known. Or take another project which is smaller in scope but no less damaging to ecology and culture: the construction of the Rzhev hydro-electric station in the upper reaches of the Volga. This section of the great river has luckily not been blocked by high dams, which are like dangerous blood clots in the vascular system of the Earth. The hydrologists seem to be busy to close this "gap" in their work. The argument they use is that Moscow is allegedly dying of thirst and therefore needs additional water supply. But where does this thirst come from? After all, the leaders of the Moscow city executive committee at one time claimed credit for the fact that every Muscovite expends 600 litres of water daily, as compared to a Londoner who uses up only 280 litres and a Parisian who satisfies his daily needs with an even smaller amount. Muscovites are notorious "drinkers" second only to their neighbours in Vladimir. Yet is it really true that a Muscovite drinks up more than half a ton of water a day? Not really. The leaky water system in Moscow is directly responsible for 20-25 per cent of the loss of water in the city. About 30 per cent of the water intake is used up for industrial needs. In addition to all that, drinking water is used for washing the streets. The way Moscow's industry uses water is outrageous. The circulating water supply in the Soviet Union averages 80 per cent, whereas in Moscow it is only 50 per cent. By the year 2000 the city fathers are planning to raise this proportion by a mere 3.5 per cent, while by the year 2020 they are prepared to go as high as 6.5 per cent, which is not nearly enough. So this is where the artificial "thirst" comes from! The Moscow city executive committee decided to quench it (with the help of Minenergo and Minvodkhoz) in a truly ingenious way: to build a high dam outside Rzhev on the Volga, and create still another man-made sea, to disrupt the normal flow of the river and flood 60 square kilometers of fertile land.

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[1] A. S. Pushkin, *Collected Works*, Vol. 10, Nauka, Moscow, p. 689 (in Russian).

And this would not only flood fertile lands, but also bury the sacred memories of our past. For Rzhev is the symbol of the victory of the valiant Red Army over the Nazis outside Moscow in 1941. The land here is dotted with the graves of our soldiers, and the grim obelisks remind us of their heroic deeds.

In his poem, "I was killed near Rzhev", Alexander Tvardovsky immortalised the memory of those who fell there:

I am where the blind rootlets
Wriggle thirstily down
Where the rye and the dust cloud
Sway upon the high ground.

. . . .

Not for us is the medal
Or the battle decoration —
They are meant for the living.
We have one consolation.
Not in vain for our homeland
Did we grapple with the foe,
Though our voices are silent,
That you surely must know.

Shall we be so callous as to a stifle this voice? I don't want to think so.

Very often we take a narrow view of nature conservation as protection of some particular outstanding natural sites, just the same way as we regard outstanding monuments of culture. After all the beauty of nature, its vitality and spiritual strength do not have necessarily to reside in something truly outstanding. They also live in simple and modest-looking things. The Russian writer M. Garshin put it very aptly in a letter he wrote from Gurzuf in the Crimea to N. Garshina in 1887: "Here I walk the same paths that Pushkin walked 65 years ago. And something very important, very profound grips my soul. I feel serene. And I want to work."

But what is it that is so important and so profound? This is not difficult to understand and can easily be summed up in just one word: "morality". Do the departmental leaders who design and build chemical plants and nuclear power station in the Crimea remember that? What could be worse than the destruction of nature to satisfy current industrial needs that are largely false and therefore senseless. This, too, is immoral and callous, for it is always linked with the loss of much greater values than they seem to be at first glance, losses most of which are irretrievable.

This is why one cannot feel indifferent to the fair judgment of our outstanding writer, subtle psychologist Valentin Rasputin who, in one of his numerous very penetrating public statements said with stabbing clarity: "Nothing erodes the soul, and nothing hollows it so such as irresponsible and irrational changes of the natural environment for the benefit of questionable, transient interests." All people, especially young people, must heed these wise words. It often so happens that this transient interest serves to satisfy our momentary desires, that it is not only temporary but indeed illusory, phantasmal. What has been done cannot be undone. But life will go on for many years. We will yet have to live and protect our land, our centuries-old culture, our spirituality. And living we should be aware of our fatal mistakes in our relations with mother nature. Therefore it is so important not to make such mistakes.

In this exciting times of democratisation in all spheres of our life, of the rising social awareness of our people, especially young people, the understanding of ecological problems has become one of the crucial conditions of the movement of society towards a safe and happy future.

CONCLUSION

> In our age, people are increasingly aware that being in contact with nature is the last word in any progress, science, reason, and common sense...
>
> *Fyodor Dostoyevsky*

The Soviet Union is facing the tremendous task of speeding up its social and economic progress. In accordance with the decisions of the 27th Congress of the CPSU, the country should double its national income by the end of this century. To achieve this, it is planned to double the country's production potential. The solution of this task calls for still more sweeping projects for the transformation of production on the basis of new technology. Do these projects accord with the tasks of nature conservation and with the laws of development of nature? Won't they clash in still more bitter fight with one another? These thoughts call to mind Karl Marx's warning that "human projects that ignore the great laws of nature will bring us nothing but calamity".[1] Do the planners, industrial managers and ministerial experts always assess the possibilities of new industrial projects and new plans for increasing their output?

It has been proven in practice that this is not so by far. Evidence of this is an excerpt from an open letter from the "Women for Nature Protection" organisation of the Krasnoarmeisk district in Volgograd to three government ministers responsible for chemical, oil and railway industries, published in the journal *Rabotnitsa* No. 4, 1988. This is what they write: "Come to our district, and you will see handsome wide streets and pleasant courtyards. However, there are numerous offers of exchange of two- and even three-room apartments for one-room apartments in other districts. Why? For the simple reason that our residential housing blocks are encircled by various chemical and petrochemical plants and factories.

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[1] Marx to Engels in Manchester, [London,] 7 August 1866, in: Karl Marx, Frederick Engels, *Collected Works*, Vol. 42, 1987, p. 305.

"Those who suffer the most from this ecological depredation are children and old people. For it is they who particularly need physical exercise and fresh air. And we, instead, tell them: 'don't go out, it's dangerous'. In summertime we keep the windows closed even on hot days. But even then we can't keep off those noxious fumes. We realise that we cannot go on living this way. We want you to understand that, as industrial leaders, you should see the world as it is, and not through the blinkers of production plans. The slogan 'Fulfill the plan at any price!' is yesterday's slogan. Today, after so many ecological catastrophes, we must understand that it must not be at the price of the natural environment. Nature is man's cradle, and there is nothing more precious than man. There must not be."

That was what the authors of this letter wrote. That was the voice of the people. And although the letter was addressed to three government ministers, it ought to be heard not only by those three ministers to whom it was addressed.

The voice of the people is the voice of God, they used to say in the old days. Those are wise words, and they must not be consigned to oblivion in our uneasy days. The problem of saving the natural environment is the problem of saving human society. It concerns all of us. "Joint action alone can lessen and remove the global danger of an ecological collapse," said Mikhail Gorbachev at the international meeting of representatives of parties and movements in Moscow, in November 1987. A good idea. What we need now is action.

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